Charles University

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Physiotherapeutic treatment of patient after a distended medicollateral- and anterocruciate ligament of the knee

Bachelor thesis

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Abstract

Topic: Physiotherapeutic treatment of patient after a distended mediocollateral- and anterocruciate ligament of the knee (fyzioteraupetická léčba pacienta po zvětšení předního zkříženého a vnitřního postranního vazu kolene).

Objective: The main aim in the treatment of this patient was to decrease the swelling around the knee, relieve pain, and increase ROM of the knee joint. Further, the stability of the knee was increased, in addition to improvement of functionality and muscle strength of the knee through therapy and exercises in the fitness room.

Subject: The patient is a 38 year old male. He injured his knee playing football in December 2009. During a football match he twisted his left knee awkwardly which resulted in severe pain and swelling around the knee. An X-ray, and an orthopedic examination in the hospital revealed hematoma by inner aperture of the knee joint, but not trauma to the skeleton. The patient is presented with a diagnosis of distension of the anterocruciate- and mediocollateral ligament. He has been wearing a full extension orthesis for a month, and is using crutches (French style).

Methods: Clinical assessment and treatment of a swollen knee over 7 sessions, in the examining room, and in the fitness room. The therapy consisted of soft tissue techniques; mobilization; muscle strengthening; balance exercises; and verbal reeducation.

Results: The swelling was decreased as shown by several centimeters of decreased circumference around the affected lower extremity. There was a marked decrease of pain in standing, although more advanced variations of locomotion still produced slight pain. There was as well as an increase in ROM of approx. 65 degrees of flexion in the knee joint, and an increased ability to extend the knee into neutral position during active movements. In the joint examination there was found less restriction of the fibular head, and the muscle strength had increased slightly in several muscles around the knee, most notable the hamstrings, and the quadriceps femoris..

Key words: anterocruciate ligament distension, knee instability, knee swelling, mediocollateral ligament distension, sports injuries.

Declaration

I declare that my Bachelor Thesis is based entirely on my own individual work under supervision from my supervisor Klára Hojková, and on my practice at Centrum léčby pohybového aparátu Vysočany, Prague, under careful guidance and advice from Mgr. El Ali Zaher, in the time period 11.01.10-19.02.10.

The list of literature I have used to compose my work is found in my bibliography.

In Prague, 5th of April 2010 Sigve Pedersen

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Secondly, I would like to thank my supervisor at Centrum léčby pohybového aparátu Vysočany, Mgr. El Ali Zaher for giving important advice on examination and therapy for the patient, both in the treatment room and the fitness room. Also, without his insightful translation it would be more challenging for me to communicate with my patient due to the obvious language barrier.

In addition, I would like to direct my appreciation towards Charles University of Physical Education and Sports, where I have my theoretical knowledge, practical background and experience from. All the teachers and professors who I have received integral knowledge from during the course of the bachelor study.

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Last, but not least, I would like to say that I owe my lovely girlfriend Jana credit for helping me with the formatting of the bachelor thesis, supporting me in my studies, and for playing such a big part in my life as she does.

Table of Content

1. Introduction

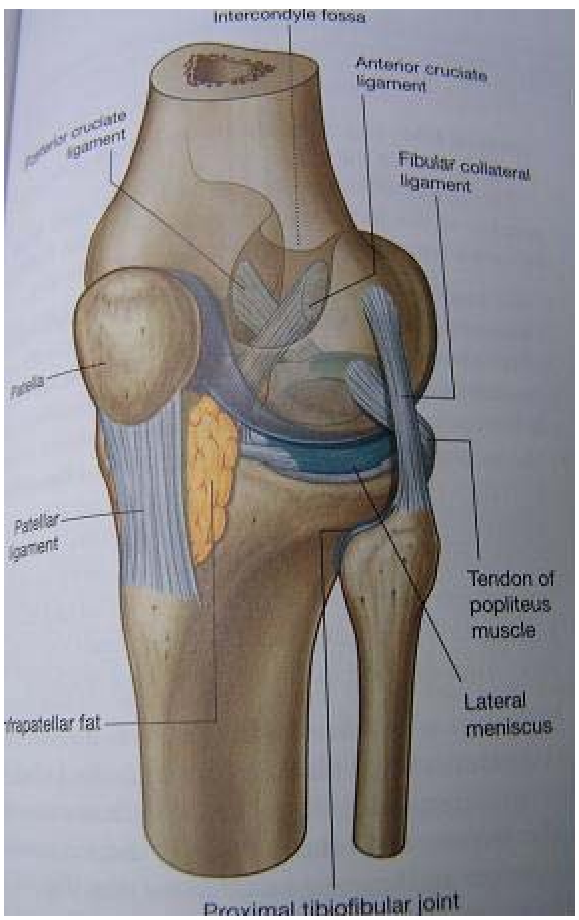
My bachelor thesis elaborates on a distended anterocruciate- and mediocollateral ligament. This includes an integral background information which is vital to know before examinating the knee, the type of examinations and assessments indicated to evaluate the state of the soft tissue around the knee, the clincial therapy of the knee joint, and differences in prognosis depending on diagnosis variations. If there is a ligament tear the rehabilitation will take months, whereas if it is only a rupture, depending on the grade, the treatment period will be significantly shorter. The practice was undertaken in Prague during the month of January in 2010 at Centrum léčby pohybového aparátu Vysočany.

2. General part

2.1 Anatomy of the knee

The knee joint is the largest synovial joint in the body. It consists of: (5)

- The articulation between the femur and tibia, which is weightbearing; (5)
- The articulation between the patella and the femur, which allows the pull of the quadriceps femoris muscle to be directed anteriorly over the knee to the tibia without tendon wear. (5)



Picture 1: Knee anatomy(1)

Two fibrocartilaginous menisci, one on each side, between the femoral condyles and tibia accommodate changes in the shape of the articular surfaces during joint movements. (5)

The detailed movements of the knee joint are complex, but basically the joint is a hinge joint that allows mainly flexion and extension. Like all hinge joints, the knee joint is reinforced by collateral ligaments, one on each side of the joint. In addition, two very strong ligaments (the cruciate ligaments) interconnect the adjacent ends of the femur and tibia and maintain their opposed positions during movement. (5)

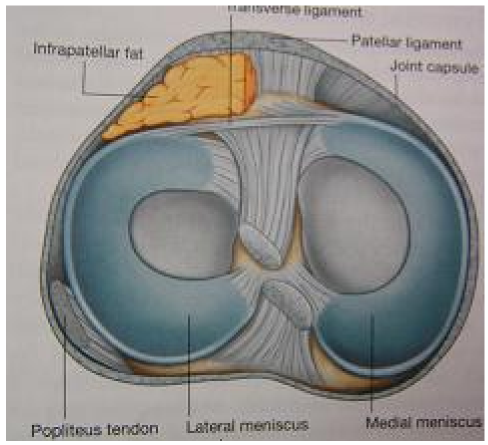
The articular surfaces of the bones that contribute to the knee joint are covered by a hyaline cartilage. The major surfaces involved include: (5)

- The two femoral condyles; (5)
- The adjacent surfaces of the superior aspect of the tibial condyles; (5)
- The surfaces of the femoral condyles that articulate with the tibia in flexion of the knee are curved or round whereas the surfaces that articulate in full extension are flat. (5)

The articular surfaces between the femur and patella are the V-shaped trench on the anterior surface of the distal head of the femur where the two condyles join and the adjacent surfaces on the posterior aspect of the patella. The joint surfaces are all enclosed within a single articular cavity, as are the intra-articular menisci between the femoral and tibial condyles. (5)

2.1.1.Menisci

There are two menisci, which are fibrocartilaginous C-shaped cartilages, in the knee joint, one medial (medial meniscus) and the other lateral (lateral meniscus). Both are attached at each end to facets in the intercondylar region of the tibial plateau. (5)



Picture 2: Menisci overview (2)

The medial meniscus is attached around its margin to the capsule of the joint and to the tibial collateral ligament whereas the lateral meniscus is unattached to the capsule. Therefore, the lateral meniscus is more mobile than the medial meniscus. The menisci are interconnected anteriorly by a transverse ligament of the knee. The lateral meniscus is also connected to the tendon of the popliteus muscle, which passes superolaterally between this meniscus and the capsule to insert on the femur. The menisci improve congruency between the femoral and tibial condyles during joint movements where the surfaces of the femoral condyles articulating with the tibial plateau change from small curved surfaces in flexion to large flat surfaces in extension. (5)

2.1.2. Synovial membrane

The synovial membrane of the knee joint attaches to the margins of the articular surfaces and to the superior and inferior outer margins of the menisci. The two cruciate ligaments, which attach in the intercondylar region of the tibia below and the intercondylar fossa of the femur above are outside the articular cavity, but enclosed within the fibrous membrane of the knee joint. (5)

Posteriorly, the synovial membrane reflects off the fibrous membrane of the joint capsule on either side of the posterior cruciate ligament and loops forward around both ligaments thereby excluding them from the articular cavity. (5)

Anteriorly, the synovial membrane is separated from the patellar ligament by an infrapatellar fat pad. On each side of the pad, the synovial membrane forms a fringed margin (an alar fold), which projects into the articular cavity. In addition, the synovial membrane covering the lower part of the infrapatellar fat pad is raised into a sharp midline fold directed posteriorly (the infrapatellar synovial fold), which attaches to the margin of the intercondylar fossa of the femur. (5)

- The synovial membrane of the knee joint forms pouches in two locations to provide low friction surfaces for the movement of tendons associated with the joint. (5)
- The smallest of these expansions is the subpopliteal recess, which extends posterolaterally from the articular cavity and lies between the lateral meniscus and the tendon of the popliteus muscle, which passes through the joint capsule. (5)
- The second expansion is the suprapatellar bursa, a large bursa that is a continuation of the articular cavity superiorly between the distal end of the shaft of femur and the quadriceps femoris muscle and tendon – the apex of this bursa is attached to the small articularis genus muscle, which pulls the bursa away from the joint during extension of the knee. (5)

2.1.3. Fibrous membrane

The fibrous membrane of the knee joint is extensive and is partly formed and reinforced by extensions from tendons of the surrounding muscles. In general, the fibrous membrane encloses the articular cavity and the intercondylar region: (5)

- On the medial side of the knee joint, the fibrous membrane blends with the tibial collateral ligament and is attached on its internal surface to the medial meniscus; (5)

- Laterally, the external surface of the fibrous membrane is separated by a space from the fibular collateral ligament and the internal surface of the fibrous membrane is not attached to the lateral meniscus; (5)

- Anteriorly, the fibrous membrane is attached to the margins of the patella where it is reinforced with tendinous expansions from the vastus lateralis and vastus medialis muscles, which also merge above with the quadriceps femoris tendon and below with the patellar ligament. (5)

The fibrous membrane is reinforced anterolaterally by a fibrous extension from the illiotibial tract and posteromedially by an extension from the tendon of semimembranosus (the oblique popliteal ligament), which reflects superiorly across the back of the fibrous membrane from medial to lateral. (5)

2.1.4. Ligaments

The major ligaments associated with the knee joint are the patellar ligament, the tibial (medial) and fibular (lateral) collateral ligaments, and the anterior and posterior cruciate ligaments. (5)

Patellar ligament

The patellar ligament is basically the continuation of the quadriceps femoris tendon inferor to the patella. It is attached above to the margins and apex of the patella and below to the tibial tuberosity. (5)

Collateral ligaments

The collateral ligaments, one on each side of the joint, stabilize the hinge-like motion of the knee. (5)

The cord-like fibular collateral ligament is attached superiorly to the lateral femoral epicondyle just above the groove for the popliteus tendon. Inferiorly, it is attached to a depression on the lateral surface of the fibular head. It is separated from the fibrous membrane by a bursa. (5)

The broad and flat tibial collateral ligament is attached by much of its deep surface to the underlying fibrous membrane. It is anchored superiorly to the medial femoral epicondyle just inferior to the adductor tubercle and descends anteriorly to attach to the medial margin and medial surface of the tibia above and behind the attachment of sartorius, gracillis, and semitendinosus tendons. (5)

Cruciate ligaments

The two cruciate ligaments are in the intercondylar region of the kne and interconnect the femur and tibia. They are termed ‘’cruciate’’ (Latin for shaped like a cross) because they cross each other in the sagittal plane between their femoral and tibial attachements: (5)

- The anterior cruciate ligament attaches to a facet on the anterior part of the intercondylar area of the tibia and ascends posteriorly to attach to a facet at the back of the lateral wall of the intercondylar fossa of the femur; (5)
- The posterior cruciate ligament attaches to the posterior aspect of the intercondylar area of the tibia and ascends anteriorly to attach to the medial wall of the intercondylar fossa of the femur; (5)

The anterior cruciate ligament crosses lateral to the posterior cruciate ligament as they pass through the intercondylar region. The anterior cruciate ligament prevents anterior displacement of the tibia relative to the femur and the posterior cruciate ligament restricts posterior displacement. (5)

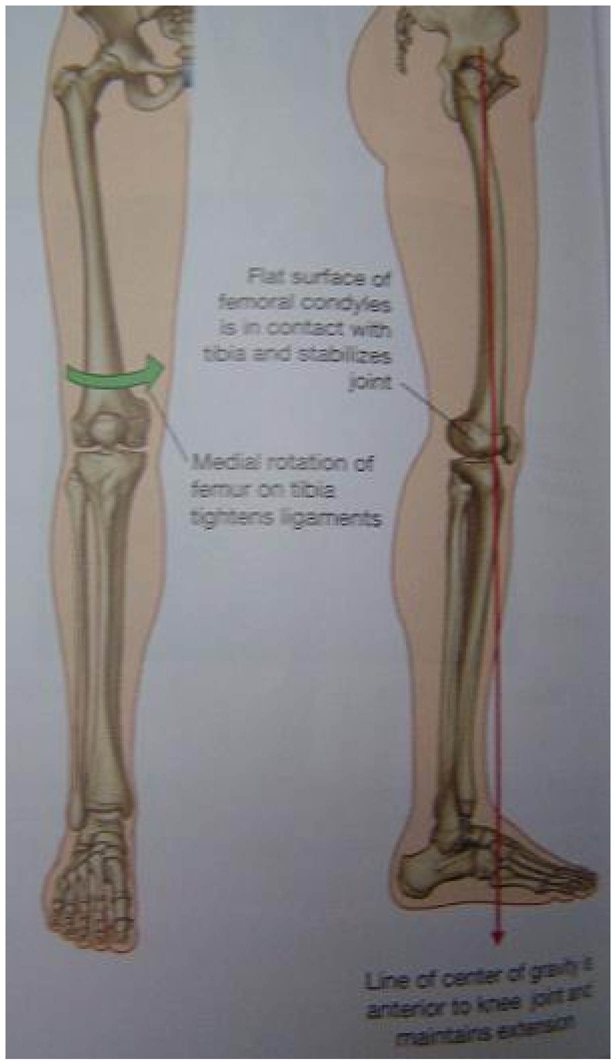
2.1.5. Locking mechanism

When standing, the knee joint is ‘’locked’’ into position, thereby reducing the amount of muscle work needed to maintain the standing position. One component of the locking mechanism is a change in the shape and size of the femoral surfaces that articulate with the tibia: (5)

- In flexion, the surfaces are the curved and rounded areas on the posterior aspects of the femoral condyles; (5)

- As the knee is extended, the surfaces move to the broad and flat areas on the inferior aspects of the condyles. (5)

Consequently the joint surfaces become larger and more stable in extension. Another component of the locking mechanism is medial rotation of the femur on the tibia during extension. Medial rotation and full extension tighten all the associated ligaments. (5)



Picture 3: Knee alignment (3)

Another feature that keeps the knee extended when standing is that the body’s center of gravity is positioned along a vertical line that passes anterior to the knee joint. The popliteus muscle unlocks the knee by initiating lateral rotation of the femur on the tibia. (5)

2.1.6. Vascular supply and innervation

Vascular supply to the knee joint is predominantly through descending and genicular branches from the femoral, popliteal, and lateral circumflex femoral arteries in the thigh and the circumflex fibular artery and recurrent branches from the anterior tibial artery in the leg. These vessels form an anastomotic network around the joint. (5)

The knee joint is innervated by branches from the obturator, femoral, tibial and common fibular nerves. (5)

2.1.7. Surface anatomy

The patella is a prominent palpable feature at the knee. The quadriceps femoris tendon attaches superiorly to it and the patellar ligament connects the inferior surface of the patella to the tibial tuberosity. The patellar ligament and the tibial tuberosity are easily palpable. A tap on the patellar tendon tests reflex activity mainly at spinal cord levels L3 and L4. The head of the fibula is palpable as a protuberance on the lateral surface of the knee just inferior to the lateral condyle of the tibia. It can also be located by following the tendon of biceps femoris inferiorly. (5)

The common fibular nerve passes around the lateral surface of the neck of the fibula just inferior to the head and can often be felt as a cord-like structure in this position. Another structure the can usually be located on the lateral side of the knee is the illiotibial tract. This flat tendinous structure, which attaches to the lateral tibial condyle, is most prominent when the knee is fully extended. In this position, the anterior edge of the tract raises a sharp vertical fold of skin posterior to the lateral edge of the patella. The medial (tibial) collateral ligament spans the tibiofemoral joint on the medial side and may be felt by palpating along the joint line. This broad fibrous band obliterates the joint line as the ligament courses from the medial epicondyle of the femur to the medial condyle and shaft of the tibia. If the palpating finger is placed on the joint line at the anterior margin of the medial collateral ligament, the edge of the medial meniscus may be palpated. (5)

2.2. Movements of the knee joint

Flexion and extension are movements about a coronal axis. Flexion is movement in a posterior direction, approximating the posterior surfaces of the lower leg and thigh. Extension is movement in an anterior direction to a position of straight alignment of the thigh and lower leg (0 degrees). From the position of zero extension, the range of flexion is approximately 140 degrees. (11)

The hip joint should be flexed when measuring full knee joint flexion to avoid restriction of motion by the rectus femoris, but the joint should not be fully flexed when measuring knee joint extension to avoid restriction by the hamstring muscles. Hyperextension is an abnormal or unnatural movement beyond the zero position of extension. For the sake of stability in standing, the knee normally is expected to be in a position of only a very few degrees of extension beyond zero. If extended beyond these few degrees, the knee is said to be hyperextended. Lateral rotation and medial rotation are movements about a longitudinal axis. Medial rotation is rotation of the anterior surface of the leg toward the midsagittal plane. Lateral rotation is rotation away from the midsagittal plane. The extended knee (in zero position) is essentially locked, preventing any rotation. Rotation occurs with flexion, combining movement between the tibia and the femur. With the thigh fixed, the movement that accompanies extension is lateral rotation of the tibia on the femur. With the leg fixed, the movement that accompanies extension is medial rotation of the femur on the tibia. (11)

2.3. Range of motion of the knee joint

Active ROM: Active ROM testing at the knee include flexion (about 135 degrees) and extension (about 0 degrees), and medial (10-20 degrees) and lateral (20-25 degrees) tibial rotation. (16)

Passive ROM: Follow active ROM with passive overpressures, or if active ROM is incomplete, examine first with full passive motion. Overpressure in flexion should be a soft tissue end feel as the calf moves against the posterior thigh. Overpressure in extension and medial and lateral rotation of the tibia is a firmer end feel as the soft tissue stretches at the end of the motion. (16)

Table Nr. 1: Knee movements

Knee	Flexion	From 120 to 150 degrees
	Extension	From 5 to -10 degrees
	Internal rotation (with the knee flexed to 90 degrees with lower leg hanging freely)	Up to 10 degrees
	External rotation (with the knee flexed to 90 degrees with lower leg hanging freely)	Up to 25 degrees

(1)

2.4. The stretch reflex mechanism of the knee

The ‘’knee-jerk’’ response is an immediate unthinking response to provocation. The spinal reflexes affecting skeletal muscles, typified by the knee-jerk, represent the simplest sets of motor behavior. Because of their reproducibility and relative simplicity, these reflexes have formed a starting point for studies of sensorimotor integration. The ‘’knee jerk’’ response comprise five elements: (4)

- A sensory receptor; (4)
- An afferent pathway to the spinal cord; (4)
- Synaptic connections, via interneurones or directly, onto; (4)
- An efferent pathway which is usually the motoneurone; (4)
- An effector (quadriceps femoris muscle). (4)

These elements are arranged to form a negative-feedback circuit. (4)

The ’’knee-jerk’’ reflex is elicited by tapping the patella tendon, which tilts the patella, thus producing a brisk stretch of the quadriceps femoris muscle. This stretch elecits a burst of impulses in the Ia afferents of the quadriceps muscle spindles. On reaching the cord, this volley of excitatory impulses to the alfa motoneurones evokes in them a burst of action potentials causing the muscle to contract. The whole process from the tendon tap to the start of the contraction takes about 25 ms. This response time of the reflex varies depending on the length of the afferent and efferent pathways. The delay in the spinal synapse is less than 1 ms. The reflex arc is therefore a potent negative-feedback pathway which acts to control muscle length, the muscle contraction acting to restore the original length of the muscle. Tendon jerks are all artificial and do not give a good representation of the physiological role of the stretch reflex. In particular, their massive overshoot and their pendular nature are clearly not features that make them obviously useful components of a control system. The significance of the tendon jerk to clinicians is that it tests the integrity of the system and the excitability of the spinal cord. (4)

2.5. Special properties of the ACL and MCL

The MCL and LCL limits movements from side to side, while the ACL and PCL prevents excessive front and back movement. Twisting injuries that cause excess forces in these ligaments can tear the ligaments. The MCL and ACL are often injured together; the management of these injuries is improving, and athletes can often return to participation in sports. Injuries to the PCL and the LCL are more difficult to treat, especially those that involve the capsule and other structures on the lateral-posterior (outer-back) portion of the knee. (14)

Ligament injuries can be graded according to the severity of the injury, most commonly into three grades as shown in the table below. (14)

Table Nr. 2: Ligament grading

Grade 1	There is tearing within the microstructure but no obvious stretching of the ligament.
Grade 2	The ligament is stretched and there is a partial tear.
Grade 3	There is a complete tear causing the ligament.

(14)

The MCL is the most commonly injured ligament in the knee. Today most MCL injuries are treated conservatively, with early rehabilitation. (14)

Medial knee stability is primarily given by the medial static and dynamic stabilizers extending from the midline anteriorly to the midline posteriorly of the knee. (14)

Table Nr. 3: Ligament structure

Static structures	Dynamic structures
The superficial MCL	The per anserinus tendons, especially the semimembranosus tendon
The posterior oblique ligament	
The middle third of the capsule ligament	

(14)

The three units of the MCL are the superficial MCL, the deep MCL and the posterior oblique ligament. These structures do not work independently, but as an integrated unit to resist abnormal loads. The superficial MCL is on an average 11 cm long and 0.5 cm wide. It originates from the medial femoral condyle just anterior to the tubercle going distally to insert 5-7 cm below the joint line on the anteromedial tibia just under the pes anserinus insertion. The anterior fibers tense throughout flexion and the posterior fibers slacken in flexion. The MCL is tight in external rotation. The middle third of the deep MCL is a short structure – about 2-3 cm long – which is attached to the meniscus underlying the MCL. The deep and superficial layers are often integrated proximally. (14)

This ligament is relatively slack to allow knee motion, but short enough to hold the meniscus firmly along its periphery. The deep portion can be ruptured both proximally and distally to the meniscal attachment regardless of the location of the tear of the superficial ligament. The posterior oblique ligament is a thickened capsular ligament originating just posterior to the superficial MCL at the condyle inserting just below the joint line. It is attached to the posterior horn of the medial meniscus. This structure is important in maintaining medial stability. The posterior oblique ligament becomes slack in flexion. (14)

Biomechanical studies show that the MCL's main function is to resist valgus and external rotation forces of the tibia in relation to the femur. The superficial MCL has been found to be responsible for 57% of medial stability 5 degrees of knee flexion and up to 78% at 25 degrees of flexion. The deep MCL accounted for 8% at 5 degrees and 4% at 25 degrees and the posterior oblique accounted for 18% and 4% respectively. (14)

2.6. Kinesiology of the knee

Functionally, the knee can support the body weight in the erect position without muscle contraction; it participates in lowering and elevating body weight (up to 0,5 M) in sitting, squatting or climbing; and it permits rotation of the body when turning on the planted foot as a football player does when avoiding a pursuing tackler. In walking, the normal knee reduces energy expenditure by decreasing the vertical and lateral oscillations of the center of gravity of the body while sustaining vertical forces equal to four to six times body weight. (17)

The multiple functions of the normal knees – to withstand large forces, to provide great stability, and to afford large ranges of motion – are achieved in a unique way. Mobility is primarily provided by bony structure, and stability is primarily provided by the soft tissues: ligaments, muscles, and cartilage. Athletic and industrial injuries to these stabilizing structures are common and are frequently caused by the larger torques developed by forces acting on the long lever arms of the femur and tibia. (17)

Axial rotation occurs in the transverse plane when the knee is flexed. When the knee is fully extended, the medial and lateral collateral ligaments are relatively tense, contributing materially to the stability of the joint. These ligaments slacken when the joint flexes, and this is one of the reasons why a considerable amount of transverse rotation may take place in the flexed position. During knee flexion more slack is produced in the lateral than in the medial collateral ligament; hence, the movement between the femoral and tibial condyles is more extensive laterally than medially. (17)

The major functional importance of the motion, however, is in closed-chain motion, in which the femur rotates on the fixed tibia as in sudden change of direction while running. Normal end-feels for passive internal and external rotation of the knee are firm. Motion is limited by capsular and ligamentous structures, including the collateral, cruciate and oblique popliteal ligaments as well as the retinacula and the illiotibial tract. (17)

Although the amount of terminal rotation of the knee is modest (about 20 degrees), it is, like axial rotation, a requisite for normal knee function. Both motions must be evaluated and regained successful rehabilitation of the knee. (17)

The condyles of the tibiofemoral joints execute both rolling and sliding movements, with the ratio of each varying in the range of motion. Rolling is predominant at the initiation of flexion, and sliding occurs more at the end of flexion. Because the length of the articular surface of the lateral femoral condyle is longer than that of the medial condyle, the movements of the two condylar surfaces differ also. (17)

2.6.1. Menisci

Weight-bearing areas of the knee are almost equal on the medial and lateral tibiofemoral surfaces with the largest area occurring when the knee is in hyperextension. With knee flexion, the weight-bearing area moves posteriorly on the tibial condyles and becomes smaller. Surgical removal of the menisci decreases the surface area and causes pressure to increase on the femoral and tibial condyles, which may lead to later osteoarthritis. (17)

The menisci are moved and controlled on the tibia by both passive and active forces. Passively, they are pushed anteriorly by the femur as the knee extends and the contact of the femoral condyles is more anterior on the tibial condyles. Conversely, the menisci move posteriorly with knee flexion. According to Kapandji (1987), a total movement of 6 mm occurs in the medial meniscus and 12 mm in the lateral meniscus. In addition, the menisci move or deform according to the direction of movement of the femoral condyles during axial rotation. Edges of the menisci are moved by their ligamentous and muscular attachments. For example, anterior movement is caused by the meniscopatellar fibers to the extensor mechanism, and posterior movement is caused by their attachments to the knee flexors (the semimembranosus and the popliteus muscle). If a meniscus fails to move with the femoral condyles, as may occur with sudden twisting or forceful movement, the meniscus may be crushed or torn by the condyles. (17)

2.6.2. Collateral ligaments

Strong medial (tibial) and lateral (fibular) collateral ligaments prevent passive movement of the knee in the frontal plane. The medial collateral ligament prevents abduction of the tibia on the femur (genu valgum, or knock knee), and the lateral collateral ligament prevents adduction of the tibia (genu varum or bowleg). Secondarily, the collateral ligaments restrain anterior and posterior displacement of the tibia as well as rotation when the knee is extended. The attachments of the collateral ligaments on the femoral condyles are offset posteriorly and superiorly to the axis for flexion. This offsetting causes the ligaments to become taut when the knee moves into extension and to become slack as the knee flexes. The collateral ligaments thus provides stability to terminal rotation of the extended knee and yet permit axial rotation in the flexed knee. Axial rotation also is fascilitated by a decrease in the congruency of the joint surfaces when the knee is flexed. The posterior aspects of the femoral condyles have a greater convexity and the intercondylar notch is wider at this point. Thus, when the knee is flexed, the mating surfaces with the tibial intercondylar tubercles and menisci are reduced, and the condyles have more freedom to rotate. (17)

2.6.3. Cruciate ligaments

The anterior and posterior cruciate ligaments provide control and stability to the knee throughout the motions of flexion and extension. These ligaments lie in the center of the joint within the femoral intercondylar fossa. The cruciate ligaments maintain a relatively constant length throughout the motions of flexion and extension even though not all of the parts are taut at the same time. In this way, these ligaments help to force the sliding motions of the condylar surfaces to occur. (17)

The anterior cruciate ligament attaches to the anterior intercondylar fossa of the tibia and courses laterally and superiorly to attach on the inside of the lateral condyle of the femur. Severance of this ligament allows anterior dislocation of the tibia on the femur. Severance of the ACL in cadavers demonstrated an anterior displacement of the tibia on the femur of 7 mm. Such attempted movement in able-bodied subjects is far less. Mean values of the anterior drawer test in college students with intact knees were measured from 1,2 to 2,7 mm at 90 degrees of flexion (Chandler, Wilson, and Stone, 1989). (17)

Picture 4: Ligaments (4)

Secondary functions of the ACL are generally considered to be that of limiting internal and external rotation (Shoemaker and Daniel, 1990). No significant differences, however, between the intact and ACL-deficient knees for internal and external rotation ranges of motion were found in an in vitro study by McQuade and associates (1989). (17)

The posterior cruciate ligaments (PCL), attaches on the posterior intercondylar fossa of the tibia and runs medially to attach on the inside of the medial femoral condyle. The PCL limits posterior displacement of the tibia on the femur. Conversely, in closed-chain motion, when the foot is planted in running, the PCL helps prevent anterior displacement (dislocation) of the femoral condyles on the tibial condyles. Normally the PCL permits only minimal passive movement. The average displacements in posterior draw tests for college students with intact knees were from 0,6 to 1,0 mm in men and from 1,2 to 1,9 mm in women when the knee was at 90 degrees of flexion (Chandler, Wilson, and Stone, 1989). (17)

2.6.4. Patellofemoral joint

The patella is a sesamoid bone set within the joint capsule to articulate with the anterior and distal saddle-shaped surfaces of the femoral condyles (trochlear surfaces). The articulating surface of the patella has a prominent vertical ridge dividing the medial and lateral articular facets. There is considerable variation, and the osseous shape does not always reflect the cartilaginous surface (Fulkerson and Hungerford, 1990). The purposes of the patella are to: (17)

- Increase the leverage or torque of the quadriceps femoris muscle by increasing its distance from the axis of motion (force arm distance); (17)
- Provide bony protection to the distal joint surfaces of the femoral condyles when the knee is flexed; (17)
- Decrease pressure and distribute forces on the femur; (17)
- Prevent damaging compression forces on the quadriceps tendon with resisted knee flexion such as deep knee bends. (Tendons are designed to withstand large tension forces but not compression or friction forces). (17)

The extensor or quadriceps mechanism stabilizes the patella on all sides and guides the motion between the patella and the femur. Distally, the patella is anchored to the tuberosity of the tibia by the strong patellar tendon. Dense fibrous retinacula and muscles anchor the patella on each side. Laterally, the patella is stabilized by superficial and deep retinacula, the illiotibial band, and the vastus lateralis muscle. When the knee is flexed, these structures move posteriorly and create lateral and tilting forces on the patella. Normally, such motion are prevented by the balanced forces created by the medial stabilizing structures: the patellofemoral ligament, the medial meniscopatellar ligament, and the oblique fibers of the vastus medialis muscle. Superiorly, the rectus femoris and the vastus intermedius attach to the base of the patella. Thus, the patella is affected by both static (fascia) and dynamic (muscle) forces. (17)

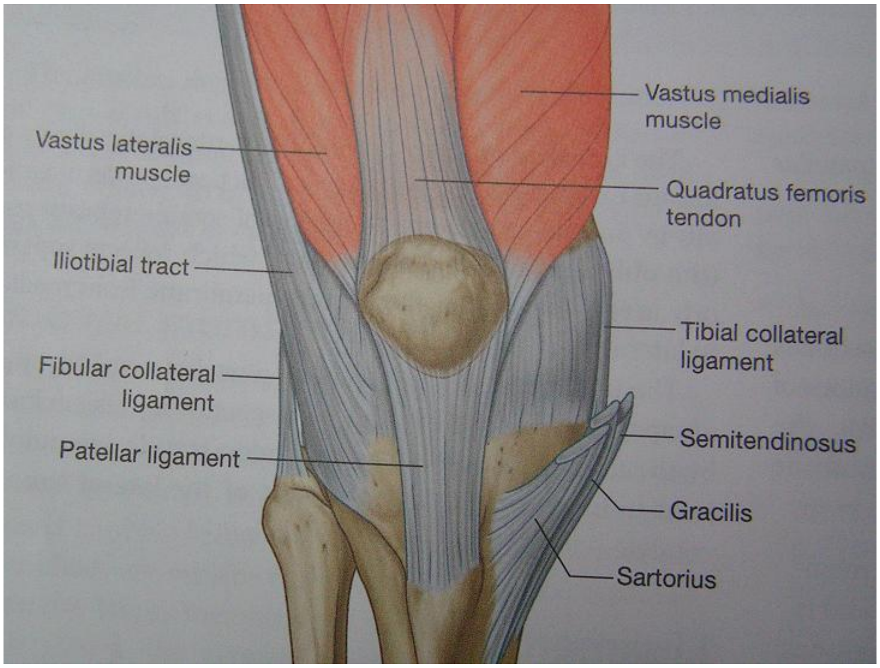
As the patella glides on the trochlear surfaces during knee flexion, the patellar articulating surfaces also change. At the beginning of the motion, the contact area is on the distal third of the patella. As flexion approaches 90 degrees, the articulating surfaces move toward the base to cover the proximal one-half of the patella (Huberti and Hayes, 1984). Huberti and Hayes found contact pressures to be the same on the medial and lateral facets and to increase with knee flexion to 90 degrees. At 120 degrees of flexion, two areas of contact and pressure occur, one is at the patellofemoral articulation, and the other is between the quadriceps tendon and the femur. (17)

2.6.5. Knee alignment and deformities

An anterior view of the extended knee reveals an angle, open laterally, between the shafts of the femur and the tibia. The size of the angle is variable; about 170 degrees (as measured from the longitudinal axis of each bone) is regarded as average. This angle is due to the adducted position of the shaft of the femur and the compensatory direction of the tibia to transmit weight perpendicularly to the foot and ground. Thus, during weight bearing on one leg, forces are directed toward the medial side of the knee. If the angle becomes smaller than 170 degrees, the condition is referred to as genu valgum, or knock knee. Conversely, if the angle approaches 180 degrees or opens medially, the deformity is referred to as genu varum, or bowleg. (17)

The tendons of the quadriceps femoris and the ligamentum patella also form an angle with the center of the patella. This is called the “Q angle” (Ficat and Hungerford, 1977). Normal values for college men were 11,2 degrees and 15,8 degrees for women (Horton and Hall, 1989). Q angles greater than 20 degrees are said to have a higher incidence of patellofemoral joint abnormalities such as chondromalaci patella and patellofemoral tracking problems. Excessive lateral displacement of the patella as it tracks on the trochlear surfaces is normally prevented by the congruence of the joint surfaces, the elevated lateral trochlear facet, and by the medial soft tissue stabilizers. Imbalances such as tightness of the illiotibial band or weakness of the vastus medialis oblique cause the patella to move laterally with muscle contraction of the quadriceps and may lead to changes in joint contact areas and pressures with resulting pain and dysfunction. (17)

2.6.6. Muscle groups acting on the knee



Picture 5: Muscles (5)

Knee extensors: The quadriceps femoris muscle group extends the knee and consists of four muscles: rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius. These four muscles form a single, strong distal attachment to the patella, capsule of the knee, and anterior proximal surface of the tibia. In well-developed subjects in whom little adipose tissue is present, the rectus femoris, the vastus medialis, and the vastus lateralis may be observed as separate units, while in other subjets, the boundaries of these muscles are less distinct. The vastus intermedius is deeply located and can not be observed from the surface. (17)

Knee flexors: A number of muscles pass posterior to the axis for flexion and extension of the knee, contributing to a variable extent of knee flexion. The muscles are the biceps femoris, the semitendinosus, and the semimembranosus (collectively called hamstrings); the gastrocnemius; the plantaris; the popliteus; the adductor gracillis; and the sartorius. (17)

Rotators

The muscles that act in internal rotation of the tibia with respect to the femur are the semitendinosus , semimembranosus, popliteus, gracillis, and sartorius. External rotation of the tibia with respect to the femur is accomplished by the biceps femoris, possibly aided by the tensor fascia latae. (17)

2.6.7. Muscle function

Knee extensors

The quadriceps femoris is a large and powerful muscle capable of generating in excess of 1000 lb (4450 N or 2200 kg) of internal force. Such great force is needed in closed chain motion to elevate and lower the body, as in rising from a chair, climbing, and jumping, and to prevent the knee from collapsing in walking , running, or landing from a jump. Here the quadriceps mechanism provides an active restraint to the femoral condyles on the tibial plateau to supplement passive restraints such as the posterior cruciate ligament and joint contours. The rectus femoris crosses the hip and is a hip flexor as well as a knee extensor. As would be expected, the muscle becomes active as a knee extensor early in the range of motion when the hip is extended and the maximum torque output of the quadriceps is increased with hip extension. This effect can be observed when a seated subject is having difficulty extending the knee against resistance. If the subject leans back to place a stretch on the rectus femoris, increased force becomes available. (17)

At one time it was thought that the vastus medialis was responsible for the last 20 to 30 degrees of knee extension. EMG studies have shown, however, that all four of the quadriceps muscles are active early and throughout the range of motion (Pocock, 1963; Leib and Perry, 1971). Basmajian (1978) found that while the onset of EMG activity in the four muscles was variable when knee extension was performed against little or no resistance, working against resistance caused all four muscles to be activated by 80 degrees of knee flexion. Anatomically and functionally, Leib and Perry (1968) further divide the vastus medialis into the vastus medialis longus (VML) and the vastus medialis oblique (VMO). The superior longitudinal fibers of the VML are directed 15 to 18 degrees medially from their attachment on the patella in the frontal plane. The prominent inferior fibers of the VMO are more obliquely directed to form an angle of 50 to 55 degrees. In a mechanical study on cadavers, the authors found that each of the quadriceps muscles except the VMO could extend the knee and that the vastus intermedius was the most efficient (required the least force). It was, however, impossible to extend the knee with the VMO regardless of the amount of force applied. The vastus medialis is believed to platy an important role in keeping the patella on track in gliding on the femoral condyles (tracking mechanism). The medially directed forces of the VMO counteract the laterally directed forces of the vastus lateralis, thus preventing lateral displacement of the patella in the trochlear groove. (17)

Knee flexors

Open chain motions of knee flexion and rotation is important for placement and movement of the foot but require little muscle force to execute (except for deceleration of the leg in walking and running). Great forces are required of these muscles, however, as they act on other joints or in closed-chain motion. The hamstring muscles are primary hip extensors and contract strongly to stabilize the pelvis during trunk extension (prone), and to control the pelvis on the femur as the seated or standing subject leans forward to touch the feet and then returns to the upright position. (17)

The hamstrings, sartorius, and the gracillis muscles have rotary actions at the hip and knee, and the popliteus is a rotator at the knee. After the foot is planted on the ground during the stance phase of walking, the knee and hip must rotate for forward motion of the body to occur over the supporting foot. The rotation is initiated and controlled by the rotator muscles. In activities such as running, turning, cutting, or maintaining balance on an unstable base of support (such as uneven ground or a rocking boat), the force required of the rotator muscles increases markedly. Activities carried out in the kneeling or squatting position (such as gardening, welding, mining, or playing football) require strong forces from the rotator muscles to initiate and control hip and knee motions on the fixed tibia in response to necessary twists of the trunk and upper extremities. Thus, injuries to the knee flexors (ie, hamstring "muscle pull") are more commonly due to their actions as rotators or as decelerators of the limb motion than as flexors of the knee. (17)

2.6.8. One-joint and two-joint muscles acting at the knee

Only five of the muscles that act on the knee are one-joint muscles: the three vasti, the popliteus, and the short head of the biceps femoris. The remaining muscles cross both the hip and knee (rectus femoris, sartorius, gracilis, semitendinosus, semimembranosus, long head of the biceps femoris, and the illiotibial tract of the tensor fasciae latae), or the knee and ankle (gastrocnemius). Thus, motions or positions of the hip and ankle influence the range of motion that can occur at the knee as well as the forces that the muscles can generate (passive and active insufficiency). Under ordinary conditions of use, two-joint muscles are seldom used to move both joints simultaneously. More often, the actions of two joint muscles is prevented at one joint by resistance from gravity or the contraction of other muscles. If the muscles were to shorten over both joints simultaneously and to complete the range of both joints, they would have to shorten a long distance and would rapidly lose tension as the shortening progressed. In natural motions, however, the muscles are seldom, if ever, required to go through such extreme excursion. The two joints usually move in such directions the the muscle is gradually elongated over one joint while producing movement at the other joint. The result is that favorable length-tension relations are maintained. (17)

2.6.9. Interaction of muscles and ligaments in function

Normally, both the dynamic contraction of muscles and the static forces of the ligaments and capsule are used to stabilize the knee. The ligaments and other soft tissues additionally provide a sensory system for proprioception and kinesthesia, as well as input for producing reflex muscle contraction to unload and protect ligaments (Barrack and Skinner, 1990). (17)

The ligaments, capsule, and other soft tissues of the knee are richly innervated with sensory nerve fibers and receptors. Mechanoreceptors have been found in human cruciate and collateral ligaments, the capsule, and synovial lining and on the outer edges of the menisci (Kennedy, Alexander, and Hayes, 1982; Schutte et al, 1987). Reflexes from joint mechanoreceptors to the muscles have been demonstrated in human subjects, including facilitation of the hamstrings and inhibition of the quadriceps with loading the ACL (Solomonow et al, 1987). Swelling in the joint capsule has long been known to produce inhibition of the quadriceps muscle and a sudden collapse of the knee. This inhibition has been considered to be caused by deformation of the mechanoreceptors in the ligaments and the capsule. Infusion of only 60 mL of normal saline solution into the joint capsule produced a 30 to 50 percent decrease of the EMG amplitude of the quadriceps muscle (Kennedy, Alexander, and Hayes, 1982). Clinically, Barrack, Skinner and Buckley (1989) demonstrated over a 25 per cent increase in the threshold for proprioception (of slow passive motion) in knees with complete ACL tears compared to the normal knees. The last two groups suggest that people with complete tears of the ACL may lose the stabilizing reflexes of ligaments as well. (17)

2.6.10.Muscle protection of ligaments

The use of muscles to unload ligaments is illustrated in walking at the termination of the swing phase. Here the hamstring muscles contract to decelerate the swinging leg and to unload the anterior cruciate ligament. In pathologic situations when muscles substitute for ligamentous action, there is an increase in muscle contraction and an increase in energy expenditure. EMG during level and grade walking in people with complete ACL ruptures showed significantly higher amplitudes in the medial head of the gastrocnemius as compared to normal subjects. This muscle, the hamstrings, and the vastus medialis and lateralis had earlier onsets of contraction in the gait cycle but were not significantly different at all grades. There was also a tendency for increased duration of contraction in the gait cycle. Although voluntary reaction time for muscular protection of the knee is too slow in many sports situations, the latter authors recommend that rehabilitation programs include coordination training. Decreased hamstring reaction time in individuals with knee injuries has been demonstrated with a 12-week dynamic closed-chain coordination program (Ihara and Nakayma, 1986). (17)

2.7. Biomechanics of the knee

Because the knee is positioned between the body's two longest bony levers, (the femur and the tibia), the potential for torque development at the joint is large. The knee is also a major weight-bearing joint. (8)

2.7.1. Forces at the Tibiofemoral Joint

The tibiofemoral joint is loaded in both compression and shear during daily activities. Weight bearing and tension development in the muscles crossing the knee contribute to these forces, with compression dominating when when the knee is fully extended. Compressive force at the tibiofemoral joint has been reported to be slightly greater than three times body weight during the stance phase of gait, increasing up to around four times body weight during stair climbing. The medial tibial plateau bears most of this load during stance when the knee is extended, with the lateral tibial plateau bearing more of the much smaller loads imposed during swing phase. Since the medial tibial plateau has a surface area roughly 60% larger than that of the lateral tibial plateau, the stress acting on the joint is less than if peak loads were distributed medially. The fact that the articular cartilage on the medial plateau is three times thicker than that on the lateral plateau also helps protect the joint from wear. (8)

The menisci act to distribute loads at the tibiofemoral joint over a broader area, thus reducing the magnitude of joint stress. The menisci also directly assist with force absorption at the knee, bearing as much as an estimated 45 per cent of the total load. Since the menisci help protect the articulating bone surfaces from wear, knees that have undergone meniscectomies are more likely to develop degenerative conditions. As knee flexion occurs and the angle of the joint increases to 90 degrees, the shear component of joint force produced by weight bearing, increases. Shear at the knee, which causes a tendency for the femur to displace anteriorly on the tibial plateaus, must be resisted by the ligaments and other supportive structures crossing the knee. Since these structures can be stretched or even ruptured under such stress, activities like deep knee bends and full squats that require load bearing during extreme knee flexion are not recommended. (8)

2.7.2. Forces at the Patellofemoral joint

Compressive force at the patellofemoral joint has been found to be one half body weight during normal walking gait, increasing up to over three times body weight during stair climbing. Patellofemoral compression increases with the knee flexion during weight bearing. There are two reasons for this: (8)

- The increase in knee flexion increases the compressive component of force acting at the joint; (8)
- As flexion increases, a larger amount of quadriceps tension is required to prevent the knee from buckling against gravity. (8)

The squat exercise, known for being particularly stressful to the knee complex, produces a patellofemoral joint reaction force on the order of 7.6 times body weight. Given the small contact area between the articulating bone surfaces, the transmitted stress at the patellofemoral joint during such maneuvers is high. (8)

2.8. Clinical examination

2.8.1. Aspection

An examination of the gait is extremely important as it gives vital clues regarding the diagnosis. This is dependent not only on normal muscles and joints, but also upon an intact CNS, PNS and normal labyrinthine function. (6)

A good general physical examination from head to toe gives vital clues in the diagnosis of most disorders, particularly generalized disorders of the skeleton like metabolic and developmental disorders. (6)

Look for symptoms such as pain, swelling, deformity, limitations of joint movements, limb weaknesses and limping of the patient. Also look for signs of anemia, weight loss and fever. (6)

2.8.2. Palpation

Different parts of the human hand are more or less able to discriminate variations in tissue features, such as relative tension, texture, degree of moisture, temperature and so on. This highlights the fact that an individual's overall palpatory sensitivity depends on a combination of different perceptive (and proprioceptive) qualities and abilities. (2)

These include the ability to register temperature variations and the subtle differences which exist in a spectrum of tissue states, ranging from very soft to extremely hard, as well as the ability to register the existence and size of extremely small entities such as are found in fibrotic tissue or tigger point activity, along with the sensitivity to distinguish between many textures and ranges in tone, from flaccid to spastic, and all the variables in between. (2)

Palpatory perception also results in a large measure from variations in the number and type of sensory neural receptors found in the skin and tissues of the knee. (2)

- Mechanoreceptors – report on light touch, deep pressure, and crude touch; (2)
- Proprioceptors – report on muscle length, tendon, and limb position; (2)

- Nociceptors – report on pain; (2)
- Thermoreceptors – report on warmth, cold, and internal temperature. (2)

2.9. Clinical assessment of the knee

Muscle traction tests are shown in a table below.

Table Nr. 4: Muscle traction tests

Test	Procedure	Assessment
Quadriceps femoris	The patient is prone. The examiner passively bends the knee to press the patient's heel against the buttocks.	Normally both heels can be pressed against the buttocks. Shortening is associated with an increased smallest distance between the heel and buttocks.
Rectus femoris	The rectus is evaluated with the patient supine. The patient holds the unaffected leg in maximum flexion. The examiner passively flexes the knee of the affected leg, which hangs over the edge of the examining table.	Normally knee flexion will be slightly greater than 90 degrees with the hip flexed. Shortening of the rectus femoris will result in knee flexion deficits, with total flexion less than 90 degrees.

Hamstring	The hamstrings are tested with the patient supine. The examiner lifts the patient’s extended leg and notes the maximum hip flexion that can be achieved without involvement of lumbar lordosis.	Flexion of less than 90 degrees is regarded as abnormal. Where the hamstrings are shortened further flexion can only be achieved by flexing the knee as well.

(1)

2.9.1. Meniscus

The menisci are important in guiding motion and ensuring stability in the knee. They also transmit and distribute compressive stresses between the femur and tibia. Meniscus injuries include tears or avulsions of the cartilage discs. Anatomic factors predispose the medial meniscus to a far higher incidence of injury than the lateral meniscus. Meniscus lesions may be degenerative or traumatic in origin. Degenerative tissue changes in the menisci, which may begin in adolescence, can lead to damage as a result of everyday activities in patients without a history of trauma or knee disease. In diagnosing knee injuries, one must always be alert to the possibility of a combined injury involving the collateral and cruciate ligaments in addition to the meniscus injury. Any insufficiently treated ligament injury with instability of the knee can also lead to meniscus damage. The primary symptoms of late sequelae of meniscus injuries include pain with exercise accompanied by occasional impingement symptoms and joint effusions with irritation. (1)

There are a number of diagnostic signs of meniscus damage. The function tests are based on pain provocation as a result of compression, traction, or shear forces acting on the meniscus. An isolated function test will rarely be sufficient to evaluate a meniscus lesion. Usually a combination of various maneuvers is required to confirm the diagnosis. (1)

Apley distraction and compression test (grinding test)

Procedure: The patient is prone with the affected knee flexed 90 degrees. The examiner immobilizes the patient's thigh with his or her knee. In this position, the examiner rotates the patient's knee while alternately applying axial traction and compression to the lower leg. (1)

Assessment: Pain in the flexed knee occurring during rotation of the lower leg with traction applied suggests injury to the capsular ligaments (positive distraction test). Pain with compression applied suggests a meniscus lesion (positive grinding test). Snapping phenomena can occur with discoid menisci or meniscal cysts. Pain in internal rotation suggests injury to the lateral meniscus or lateral capsule and/or ligaments; pain in external rotation suggests injury to the medial meniscus or medial capsule and/or ligaments. (1)

McMurray test (Fousche sign)

Procedure: The patient is supine with the knee and hip of the affected leg in maximum flexion. The examiner grasps the patient's knee with one hand and the patient's foot with the other. Holding the patient's lower leg in maximum external and internal rotation, the examiner then passively extends the knee into 90 degrees of flexion. (1)

Assessment: Pain while extending the knee with the lower leg externally rotated and abducted suggests a medial meniscus lesion; pain in internal rotation suggests an injury to the lateral meniscus. A snapping sound in extreme flexion occurs when a projecting meniscal flap becomes impinged on the posterior horn, Snapping in 90 degrees flexion suggests an injury in the middle section of the meniscus. (1)

Payr test

Procedure: The patient is supine. The examiner immobilizes the patient's knee with his or her left hand and palpates the lateral and medial joint cavity with the thumb and index finger, respectively. With the other hand, the examiner grasps the patient's ankle. With the knee maximally flexed, the lower leg is externally rotated as far as possible. Then with the knee in slight adduction (varus stress), the leg is flexed further in the direction of the contralateral hip. (1)

Assessment: Pain in the posterior medial joint cavity suggests damage to the medial meniscus. The posterior horn of the lateral meniscus can be similarly examined with the knee internally rotated and abducted (valgus stress). (1)

Steinmann I sign

Procedure: The patient is supine. The examiner immobilizes the patient's flexed knee with the left hand and grasps the lower leg with the other hand. The examiner then forcefully rotates the lower leg in various degrees of knee flexion. (1)

Assessment: Pain in the medial joint cavity in forced external rotation suggests damage to the medial meniscus; pain in the lateral joint cavity in internal rotation suggests damage to the lateral meniscus. Because the localization of the tear can vary, the test for the Steinmann 1 sign should be performed with the knee in varying degrees of flexion. (1)

Steinmann II sign

Procedure: The patient is supine. The examiner grasps the knee with the left hand and palpates the joint cavity. With the right hand, the examiner grasps the patient's lower leg slightly proximal to the mortise of the ankle. With the patient's thigh immobilized, the examiner places the lower leg first in external rotationm then in internal rotation, in each case alternately flexing and extending the lower leg while applying slight axial compression. (1)

Assessment: Pain in the medial or lateral joint cavity suggests a meniscus injury. The tenderness to palpation in the joint cavity migrates medially and posteriorly during flexion and slight external rotation of the knee; it then migrates back anteriorly as the knee is extended. Where a meniscus injury is suspected and the lower leg is placed in internal rotation, the tenderness to palpation will migrate anteriorly as the knee is extended and posteriorly as it is flexed. (1)

Boehler-Kroemer test

Procedure: The patient is supine. The examiner stabilizes the lateral femur with one hand and grasps the medial malleolus with the other. With the lower leg abducted (valgus stress applied), the examiner the passively flexes and extends the knee. With his or her hands on the patient's lateral malleolus and medial thigh, the examiner grasps the leg and flexes and extends the knee with the lower leg adducted (varus stress applied). (1)

Assessment: Flexing and extending the knee with the lower leg alternately adducted and abducted (the Kroemer test) alternately increases compression of the medial meniscus and lateral meniscus. Opening the medial cavity creates a valgus stress for testing the lateral meniscus; opening the lateral cavity creates a varus stress for testing the medial meniscus. (1)

Merke test

Procedure: The patient bears weight on the affected leg with the knee slightly flexed. The examiner immobilizes the foot of the affected leg. The examiner lifts the patient's contralateral leg slightly and asks the patient to internally and externally rotate the thigh of the affected leg. (1)

Assessment: Because of the increased axial compression due to the weight of the body, the Merke test usually elicits more severe pain. Pain occurring in the medial joint cavity in internal rotation of the thigh suggests a medial meniscus lesion. Pain occurring in external rotation of the thigh suggests a lateral meniscus lesion. The merke test is occasionally positive in the presence of collateral ligament lesions. (1)

Finochietto sign

Procedure: Simultaneous testing of cruciate ligament and meniscus injuries. The patient is supine. The anterior drawer test is performed with the knee flexed 90 degrees. (1)

Assessment: Where the injury also involves an anterior cruciate ligament tear, the anterior drawer test with the knee flexed 90 degrees will cause anterior displacement of the tibia. The laxity of the knee ligaments causes the femoral condyle to ride up over the posterior horn of the medial meniscus under the stress of the anterior drawer. A positive Finochietto test produces an audible snap and/or a palpable skip. If the tibia is then pressed posteriorly, the femoral condyle will glide back down from the posterior horn of the medial meniscus. (1)

Turner sign

A meniscus lesion will often be accompanied by an irregular hyperesthetic area measuring approximately 4-5 cm. This area will be located at the level of and slightly proximal to the medial joint cavity on the medial aspect of the knee or along the course of the infrapatellar branch of the saphenous nerve. Thermal and mechanical stimuli (tapping) are used to test the area for local hypersensitivity. (1)

Anderson Medial and Lateral Compression test

Procedure: The patient is supine. The examiner grasps the patient's lower leg and immobilizes the foot between his or her own forearm and waist. With the free hand, the examiner palpates the anterior joint cavity. The examiner then flexes the knee 45 degrees while applying a valgus stress and extends it while applying a varus stress. This produces a circular movement in the knee. (1)

Assessment: A longitudinal or flap tear in meniscus causes pain and/or friction rub at the level of the joint cavity. Complex tears led to chronic friction rub. (1)

Paessler rotational compression test

Procedure: The patient is seated. The examiner immobilizes the foot of the leg to be examined, holding it between his or her own legs slightly proximal to the knees. To evaluate the medial meniscus, the examiner rests both thumbs on the medial joint cavity and moves the patient's knee in a circle in the form of external and internal rotational movements. This causes the knee to move through various degrees of flexion. At the same time, the examiner applies a varus or valgus stress, respectively. (1)

Assessment: The test is positive when the patient reports pain with the circular motion. It is considered strongly positive when pain can be elicited by the circular motion alone in either the medial joint cavity (suspected lateral meniscus lesion) or the lateral joint cavity (suspected medial meniscus lesion). (1)

Tschaklin sign

Quadriceps athrophy is often encountered in chronic meniscus lesions. Atrophy of the vastus medialis in medial meniscus lesions is often associated with compensatory increase in muscle tone in the sartorius, which is known as the Tschaklin sign. (1)

Wilson test

Procedure: Demonstrates osteochondritis dissecans on the medial femoral condyle. The examiner grasps the patient's knee proximal to the patella with one hand, palpating the medial joint cavity. (1)

Assessment: In osteochondritis dissecans, compression due to joint motion and the palpating finger will produce symptoms between 20 degrees and 30 degrees of flexion. These symptoms can then typically be reduced by externally rotating the lower leg. (1)

2.9.2. Knee ligament stability test

The knee is stabilized by the ligaments, menisci, the shape and congruency of the articular surfaces, and the musculature. The ligaments ensure functional congruency by guiding the femur and tibia and limiting the space between them. Ligament injuries lead to functional impairment of the knee with instability. Knee ligament stability tests can help to identify and differentiate these instabilities. Abnormal directions of motion can be divided into three categories: (1)

1. Direct instability in a single plane(1)
2. Rotational instability(1)
3. Combined rotational instability(1)

Clinical instability is divided into three degrees. Estimated joint opening or drawer of up to 5 mm is defined as 1+ (or +), 5-10 mm as 2+ (++), and over 10 mm as 3+ (or +++).(1)

Abduction and adduction test (valgus and varus stress test)

Procedure: The patient is supine. The examiner grasps the patient's knee at the tibial head with both hands while palpating the joint cavity. The examiner immobilizes the patient's distal lower leg between his or her own forearm and waist while applying a valgus and varus stress to the knee. The fingers resting on the joint cavity can palpate any opening of the joint. (1)

Assessment: Lateral stability is assessed in 20 degrees of flexion and in full extension. Full extension prevents lateral opening as long as the posterior capsule and posterior cruciate ligament are intact, even if the medial collateral ligament is torn. In 20 degrees of flexion, the posterior capsule is relaxed. Applying a valgus stress in this position evaluates the medial collateral ligament alone as the primary stabilizer. This allows the examiner to identify the nature of damage to the posteromedial capsular ligaments. The opposite applies to adduction (varus) stress. In 20 degrees of flexion, the primary lateral stabilizer is the lateral collateral ligament. The anterior cruciate ligament and popliteus tendon act as secondary stabilizers. (1)

2.9.3. Function tests to assess the anterior cruciate ligament

Lachman test

Procedure: The patient is supine with the knee flexed 15-30 degrees. The examiner holds the femur with one hand while pulling the tibia anteriorly with the other. The quadriceps and knee flexors must be completely relaxed. (1)

Assessment: The anterior cruciate ligament is damaged when mobility of the tibia with respect to the femur can be demonstrated. The end point of motion must be soft and gradual without a hard stop; any hard stop suggests a certain stability of the anterior cruciate ligament. A hard endpoint within 3 mm suggests complete stability of the anterior cruciate, whereas one after 5 mm or more suggests relative stability of the anterior cruciate ligament, such as may be present following an earlier sprain. Cruciate ligament injury should be suspected where the endpoint is soft or absent. In the presence of a drawer exceeding 5 mm, comparison with the contralateral knee is helpful in excluding congenital laxity of the articular ligaments. A positive Lachman test is certain proof of anterior cruciate ligament insufficiency. (1)

Anterior Drawer test in 90 degrees flexion

Procedure: The patient is supine with hip flexed 45 degrees and the knee flexed 90 degrees. The examiner sits on the edge of the examining table and uses his or her buttocks to immobilize the patient's foot in the desired rotational position. The examiner then grasps the tibial head with both hands and pulls it anteriorly with the patient's knee flexors relaxed. The test is performed in a neutral position, with the foot in 15 degrees of external rotation to assess anterior and medial instability, and with the foot in 30 degrees of internal rotation to assess anterior and lateral instability. (1)

<u>Assessment:</u> The anterior drawer test in 90 degrees of flexion is often negative in acute injuries because pain often prevents the patient from achieving this degree of flexion and causes reflexive muscle contraction, Aditionally, these are usually combined injuries involving complete or partial ligament tears so that the stress of the drawer test stretches the partially torn medial and lateral structures. The resulting pain produces false-negative test results, giving the appearance of a stable joint. (1)

Jakob maximum drawer test

<u>Procedure:</u> The patient is supine with the knee flexed 50-60 degrees. The examiner pushes the tibial head into maximum anterior subluxation with his or her forearm while grasping the patient's contralateral knee with the hand of the same arm. With the other hand, the examiner grasps the tibial head and palpates how far anteriorly the medial or lateral joint cavity is displaced. The patient's lower leg is not immobilized in this test so that rotation is not restricted. This allows maximum tibial displacement. (1)

<u>Assessment:</u> See anterior drawer test in 90 degrees flexion. (1)

Jakob graded pivot shift test

<u>Procedure:</u> The patient is supine. The examiner grasps and immobilizes the lateral femoral condyle with one hand and palpates the proximal tibia or fibula with the thumb. With the other hand, the examiner holds the patient's lower leg in internal rotation and abduction (valgus stress). From this starting position the knee is then moved from extension into flexion. (1)

<u>Assessment:</u> Pivot shift grade 1: the pivot shift test is positive only in maximum internal rotation; it is negative in neutral and internal rotation. The subluxation as the knee approaches extension is more palpable than visible to the examiner (slight translation may be apparent).

Pivot shift grade 2: the pivot shift test is positive in internal and neutral rotation; however, it is negative in external rotation. There is visible and palpable translation on the lateral aspect of the joint. Pivot shift grade 3: The pivot shift test is clearly positive in neutral rotation and particularly conspicuous in external rotation. The sign is less distinct in internal rotation. Pivot shift test grade 4: can only be demonstrated in acute knee injuries where the posteromedial and lateral structures are damaged in addition to the anterior cruciate. (1)

Medial shift test

Procedure: The examiner immobilizes the patient's lower leg between his or her forearm and waist to evaluate the medial or lateral translation (tibial displacement) as the knee approaches extension. To assess medial translation, the examiner places one hand on the lower leg slightly distal to the medial joint cavity while the other hand rests on the lateral thigh. While applying a valgus stress to the knee via the lower leg, the examiner presses presses medially with the hand resting on the patient's thigh. (1)

Assessment: In an anterior cruciate tear, the tibia can be displaced medially until the intercondylar eminence comes in contact with the medial femoral condyle. Because the posterior cruciate ligament courses from medial to lateral, lateral translation on the tibial head will be detectable in the presence of a posterior cruciate tear (positive lateral shift test). (1)

Soft pivot shift test

Procedure: The patient is supine. The examiner grasps the patient's foot with one hand and the calf with the other. First, the examiner alternately flexes and extends the knee carefully, using these normal everyday motion sequences to alleviate the patient's anxiety and reduce reflexive muscle tension. The patient's hip is abducted, and the foot is held in neutral or external rotation. Next the examiner gently applies axial compression after about 3-5 flexion and extension cycles. With the hand resting on the calf, the examiner applies a mild anterior stress. (1)

Assessment: Under axial compression and mild anterior stress, slight subluxation will occur as the knee approaches extension, with reduction occurring as flexion increases. By varying the speed of the flexion and extension cycle, the axial compression, and anteriorly directed pressure, the examiner can precisely control the intensity of the subluxation and subsequent reduction. (1)

Martens test

Procedure: The patient is supine. The examiner stands lateral to the injured leg and immobilizes the patient's calf distal to the knee with one hand, resting the index finger on the fibula. The patient's lower leg is immobilized between the examiner's forearm and waist while a valgus stress is applied. While pulling the lower leg anteriorly with one hand, the examiner pushes the distal thigh posteriorly with the other. (1)

Assessment: The maneuver begins with the knee in a position approaching extension. As flexion is increased from this starting position, the subluxated lateral portion of the tibia will reduce at about 30 degrees of flexion if an anterior cruciate ligament injury is present. (1)

Losee test

Procedure: The patient is supine. The examiner grasps the knee laterally with the thumb posterior to the fibular head and the fingers resting on the patella. The other hand grasps the lower leg medially proximal to the ankle. The examiner moves the lower leg into slight external rotation. (1)

Assessment: When the knee is extended from 40-50 degrees of flexion, an anterior cruciate ligament injury will lead to visible and palpable anterior subluxation of the lateral portion of the tibial head. (1)

Slocum test

Procedure: The patient lies on the unaffected side with the hip and knee flexed, holding the injured upper leg in slight internal rotation with the foot extended where possible. In this position, the weight of the leg exerts a slight valgus stress. The examiner stands behind the patient and grasps the patient's thigh with one hand, palpating the fibular head with the thumb or index finger. (1)

Assessment: In an injury to the anterior cruciate ligament, the lateral tibial head will subluxate anteriorly with the knee in a position approaching extension. Subsequent flexion will then lead to posterior reduction of the tibial head at about 30 degrees of flexion. (1)

Arnold crossover test

Procedure: The examiner immobilizes the foot of the patient's injured leg. The patient then crosses the normal leg over the injured leg, rotating the pelvis and the trunk toward the injured side. (1)

Assessment: The contraction of the quadriceps femoris causes the immobilized leg to reproduce the lateral pivot shift phenomenon. The patient will experience an unpleasant sensation and report that the knee is about to dislocate. (1)

Noyes test

Procedure: The patient is supine. The examiner grasps the tibial head with both hands and immobilizes the patient's distal lower leg between his or her forearm and waist. With the knee in about 20 degrees of flexion, the examiner elicits a slight anterior drawer motion while simultaneously using the index fingers to evaluate whether the hamstrings are relaxed. The distal femur will drop into external rotation and slightly recede posteriorly (subluxation). The knee is then flexed from this position. (1)

Assessment: In contrast to other dynamic anterior subluxation tests, it is not the lateral portion of the tibia but the distal femur that is tested for reduction and subluxation relative to the tibial head, which the examiner immobilizes and guides posteriorly. The test is positive when knee flexion results in palpable internal rotation of the distal femur (reduction). This indicates cruciate ligament insufficiency. (1)

Jakob giving way test

Procedure: The patient leans against the wall on the normal side and distributes his or her body weight over both legs. The examiner places one hand each proximal and distal to the injured knee and applies a valgus stress while the patient flexes the knee. (1)

Assessment: The test is positive when anterior subluxation of the tibial head occurs and the patient reports a subjective sensation of the knee “giving way”. (1)

Lemaire test

Procedure: The patient is supine. The examiner internally rotates the patient’s foot with one hand while pressing against the lateral thigh with the other hand, which rests proximal to the lateral femoral condyle. The examiner then carefully extends and flexes the knee. (1)

Assessment: In an anterior cruciate ligament tear, the examiner will observe anterior subluxation of the lateral tibial head as the knee approaches extension. Spontaneous reduction will then occur at 30-50 degrees of flexion. (1)

2.10. Objective examinations of the knee

2.10.1. Arthroscopy

This endoscopic procedure permits direct visual inspection of a joint, most often the knee. In an arthroscopic examination, a surgeon makes a small incision in the patient’s skin and then inserts pencil-sized instruments that contain a small lens and lighting systems to magnify and illuminate the structures inside the joint. Light is transmitted through fiber optics to the end of the arthroscope that is inserted into the joint. By attaching the arthroscope to a miniature television camera, the surgeon is able to see the inside of the joint through this very small incision. It is frequently used to evaluate injuries suffered by athletes. Arthroscopy is useful in detecting arthritis, torn meniscus, cysts, or loose pieces of tissue. The television camera attached to the arthroscope displays the image on a television screen allowing the surgeon to look throughout the knee to determine the amount or type of injury. Some surgical procedures can be performed through the scope thereby eliminating open surgery. (10)

2.10.2. Computed Tomography (CT) Scan

A special x-ray in which the x-ray tube moves around the patient. A computer takes the information and reconstructs a cross sectional (axial) “slice” of the patient. Multiple slices are taken which allow the physician to determine the anatomy in three dimension. (10)

2.10.3. Magnetic Resonance Imaging (MRI)

The process uses strong magnets which cause all of the protons in the field to "line up". Radio waves are the passed through the patient causing the protons to resonate. A computer takes this information and constructs images in any plane. This technology has three advantages over CT scans: (10)

- There is no ionizing radiation (x-ray) used; (10)
- Soft tissues are seen in more detail; (10)
- Images can be constructed in any plane (not just axial). (10)

The major disadvantage is that the technique is expensive. There are also some factors that prevent many patients from being candidates for the procedure, such as obesity or claustrophobia. (10)

2.10.4. X-ray

A frequently used test that evaluates the condition of bones in such cases as dislocations, sprains and fractures. X-ray can also be used to determine bone structure changes like those occurring in some metabolic conditions such as acromegaly (gigantism), osteoporosis, or with Paget's disease. (10)

2.11. Knee injuries

The location of the knee between the long bones of the lower extremity, combined with its weight bearing and locomotion functions, make it susceptible to injury, particularly during participation in contact sports. A common injury mechanism involves the stretching or tearing of soft tissues on one side of the joint when a blow is sustained from the opposite side during weight bearing. (8)

2.11.1.Ligament injuries

Although the anterior cruciate ligament is injured more frequently than the posterior cruciate ligament, forced flexion of the knee, combined with internal rotation of the tibia during sports such as wrestling and football, is one documented injury mechanism for the posterior cruciate ligament. Blows to the lateral side of the knee are much more common than blows to the medial side because the opposite leg commonly protects the medial side of the joint. When the foot is planted and a lateral blow of sufficient force is sustained, the result is sprain or rupture of the medial collateral ligament. Although in contact sports such as football the medial collateral ligament is more frequently injured, both medial and lateral collateral ligament sprains occur among wrestlers. Ligament injuries constitute 25% of all injuries sustained during Alpine skiing, with the medial collateral ligament and the anterior cruciate ligament injured ten times more often than the lateral collateral ligament and the posterior cruciate ligament. A common injury mechanism involves fixation of a ski when a tip is caught in the snow or when the ski tips cross, with the skier simultaneously twisting and falling. (8)

2.11.2. Meniscus injuries

Because the medial collateral ligament attaches to the medial meniscus, stretching or tearing of the ligament can also result in damage to the meniscus. A torn meniscus is the most common knee injury, with damage to the medial meniscus approximately 10 times as frequent as damage to the lateral meniscus. This is partly due to the meniscus being more securely attached to the tibia, and therefore less mobile than the lateral meniscus. The mechanism of injury frequently involves the foot being planted during weight bearing while the body undergoes rotation. The condition is problematic in that the unattached cartilage often slips from its normal position, interfering with normal joint mechanics. Symptoms include pain, which is sometimes accompanied by intermittent bouts of locking or buckling of the joint. (8)

2.11.3. Illiotibial band friction syndrome

The tensor fascia lata develops tension to assist with stabilization of the pelvis when the knee is in flexion during weight bearing. This increases the friction of the attached illiotibial band against the lateral condyle of the femur during flexion/extension of the knee and may result in symptoms of pain and tenderness over the lateral aspect of the knee. This condition is an overuse syndrome relatively common among runners and is sometimes referred to runner’s knee. Excessive pronation of the foot results in increased internal rotation of the tibia during locomotion and contributes in some cases of illiotibial band friction syndrome. Other factors that may contribute to the syndrome involve tibial alignment and the size of the lateral femoral condyle. (8)

2.11.4. Breaststroker's knee

A condition of pain and tenderness localized on the medial aspect of the knee is often associated with performance of the whip kick – the kick used with the breaststroke. The forceful whipping together of the lower legs that provides the propulsive thrust of the kick often forces the lower leg into slight abduction at the knee, with subsequent irritation to the medial collateral ligament and the medial border of the patellar tract. A survey of 391 competitive swimmers revealed incidences of knee pain among 73% of the breaststroke specialists and 48% of nonbreaststrokers. In a study of breaststroke kinematics, it was found that angles of hip abduction of less than 37 degrees or greater than 42 degrees at the initiation of the kick resulted in a dramatically increased incidence of knee pain. (8)

2.11.5. Chondromalacia

An imbalance in tension on the medial and lateral sides of the patella can cause mistracking of the patella during knee flexion/extension movements. Tissue irritation and pain result. This condition, known as chondromalacia, often results from an imbalance between the strength of the vastus medialis oblique (VMO) and the vastus lateralis (VL). More commonly, the patella deviates laterally during tracking, with weakness of the VMO implicated. Researchers have hypothesized that proper tracking of the patella may require maintenance of a certain threshold strength in the VMO. If the patellar misalignment is not extremely severe, simple strengthening of the quadriceps muscles can alleviate, or even eliminate, the symptoms. Patellofemoral alignment problems are more frequent in females than in males. (8)

2.11.6. Shin splints

Generalized pain along the anterolateral and posteromedial aspect of the lower leg is commonly known as shin splints. This is a loosely defined overuse injury often associated with running or dancing that may involve microdamage to muscle attachments on the tibia and/or inflammation on the periosteum. Common causes of the condition include running or dancing on a hard surface or running uphill. A change in workout conditions or rest usually alleviates shin splints. (8)

2.12. Orthoses

Patellar stabilizing orthoses:

- Recurrent subluxation/dislocation of patella; (7)
- Chondromalacia patellae; (7)
- Osgood-Schlatter’s disease; (7)
- Assist patella to track normally; (7)
- Protect against subluxation/dislocation; (7)
- Control pain. (7)

Ligamentous instability:

- Designed to provide mechanical stability to those who have had ligamentous deficiencies or who have had ligament reconstruction without impeding performance; (7)
- Increase performance in patients with instability and weakness; (7)
- Decrease pain; (7)
- Allow patient to return to higher lever of activity. (7)

Osteoarthritis:

- These braces are indicated for pain relief and joint degeneration associated with medial or lateral unicompartmental osteoarthritis; (7)
- Depending on which compartment is affected, apply either a varus or valgus force on the knee; (7)

- Help redistribute weight absorbed by the compressed side of the knee joint. (7)

Postoperative or rehabilitative:

- These braces are designed to provide rigid immobilization at selected angles or controlled motion of the injured knee treated surgically or nonsurgically; (7)
- Decrease load of healing tissue; (7)
- Adjustable to various leg shapes/sizes (edema). (7)

Prophylactic knee orthoses:

- These braces are designed to prevent or reduce the severity of the knee injury while not inhibiting knee mobility in people without knee injuries; (7)
- Prevent knee injury from occurring; (7)
- Protect medial and collateral ligaments from contact injuries. (7)

Treatment

2.13. Physiotherapeutic treatment of knee swelling in acute stage

2.13.1. Lymphatic massage

When the lymphatic system fails

If a lymphatic territory becomes blocked because the system has failed to remove the normal load of fluid, the area drained by it will swell. This is the condition known as lymphoedema. If the blockage is near the top of an arm or leg, territories further away may also suffer a build-up of lymph. In this event, some action is or treatment is needed to help the system function properly again. A blocked territory can, for example, be helped to drain by opening up pathways across watersheds to other territories (for instance by lymphatic massage). This is the basis of many of the treatments for lymphoedema and certainly is an important aspect of Kinesio Taping Method. (9)

When there is a build-up of lymph, some cells in the affected tissue may also fail to function properly. This is commonly the case with macrophages, and white blood cells, which help to protect the body from disease and keep body tissue in good condition. Other cells, such as the fibroblasts may proliferate and produce more collagen, which is a fibrous material, which is normally important to hold the tissues together. But when there is an abnormal quantity of fibrotic material, such as might occur in a scar after radiotherapy, or when the macrophages are not working optimally, the increased fiber levels can reduce the function of the lymph drainage system. (9)

- Lymphoedema is classified as a primary or secondary (aquired) disorder; (9)
- Primary lymphoedema is a congenital abnormality of the lymphatic system; (9)
- Secondary lymphoedema is a result of obstruction or interruption of the lymphatic system. (9)

It is most commonly due to surgical or radiation treatment of lymph nodes associated with cancer management but can occur subsequent to post operative/radiation infection or a range of other issues which may affect the transport capacity of the lymphatic system. (9)

Lymphoedema (the swelling) and its associated co-morbidities usually has a significant impact on the quality of life, of the affected individual. It may affect work, home, and personal care functions. It can also as cause problems with sport and recreational activities, as well as sexual and social relationships. It is the lymphoedema and the co-morbidities and their signs and symptoms that we are attempting to improve through targeted treatment approaches. (9)

Lymphoedema becomes clinically manifested, when the size and circumference of the affected limb compared to the normal one is observably increased. Generally when observable there is often about an extra 200-ml of fluids, other structures, and substances in the limb. The circumference of the affected limb is compared to the normal one can be 2 cm or more in difference. (9)

Primary lymphoedema is due to a developmental abnormality of the lymphatic system. The outcome is a reduced lymphatic transport just as occurs with secondary lymphoedema. The age at onset of symptoms varies, and it is this, which is used to define the three forms of disorders, which are: (9)

- Milroy's primary congenital lymphoedema (Milroy-Nonne disease or hereditary lymphoedema type 1) - in which symptoms are often seen at birth or within the first few years of life. It, like the secondary lymphoedemas is progressive and life-long. It is inherited as an autosomal dominant disease, although not all carriers are symptomatic. (9)
- Meige's disease (Letessier-Meige disease or lymphoedema praecox) - this is the most common form of primary lymphoedema. Symptoms most often occur around puberty. It is probably related to hormonal changes or changes in their balance. (9)
- Lymphoedema tarda – in this group the first symptoms appear after the age of 35 years. Individuals, suffering from it, may identify an insect bite, joint strain, or skin infection as being the precipitating cause although many have no idea why it developed. (9)

Secondary lymphoedema is diagnosed after the exclusion of the other causes of limb or structure swelling edema such as heart failure, kidney failure, liver failure, venous disease (phlebitis), vein harvesting and secondary lymph node disorders. Just as there are a number of forms of primary lymphoedemas, so too, are there of secondary lymphoedemas. The major causes of secondary lymphoedema are: (9)

- Latrogenic:
  - Surgical removal of lymph nodes and vessels; (9)
  - Radiotherapy to lymph nodes or major collectors; (9)
  - Other surgical procedures to the limb (often those involving the venous system). (9)
- Trauma:
  - Motor vehicle accidents (MVA's) or other accidents causing damage to the drainage pathways; (9)

    - Lymphangitis; (9)
    - Fungal; (9)
    - Bacterial; (9)
    - Parasitic (including filiariasis); (9)
    - Insects, spider bites. (9)
- Cancer:
    - Intra-lymphatic tumor blockage; (9)
    - Extra-lymphatic compression by tumor; (9)
    - Angiosarcoma (Stewart-Treves syndrome). (9)

Secondary lymphoedema is more common than the primary form. From a worldwide perspective by far the most common cause of lymphoedema is through infection by a number of different forms of filarial parasites. Some estimates suggest 120-150 million people are infected across tropical and sub-tropical Africa, India, South and Central America, Asia, and the Pacific. (9)

Lymphoedema of the lower limbs often follows the excision of inguinal lymph nodes for the treatment cancers of the bowel, reproductive, and urinary systems. The data suggest that it is at least as common of that associated with excision of the axillary lymph nodes. Importantly, we must realize that lymphoedemas of the legs occur in both men and women, the former of which is rarely noticed until their condition is severe. While the risk factors are similar to those for arm lymphoedema, one of the major differences is the significant exacerbating role that disorders/disease of the venous system and diabetes etc. play. The significant other disadvantage, for those with lymphoedema of the legs, is the fact that the majority of time they are in a dependent position. Lymphoedema of the legs (and lower abdominal areas) thus represent the greatest challenge in terms of treatment and management. (9)

In attempting to either reduce the risk of a lymphoedema developing, or better manage an existing lymphoedema, there are two key and crucial points to keep in mind.

- Firstly, the fluids and their contents which leave the vascular system need to be cleared from the involved tissue, whether it be your digit, part of a limb, the whole limb, or whole body. The ability to move the fluid and their contents depend on the balance between the load awaiting removal and the transport capacity of the lymphatic system. (9)
- Secondly, in order for the transport aspect of the lymphatic system to be functional at an optimal level, the fluids and their contents need to be loaded into the initial capillaries of the lymphatic system. It is primarily variation in tissue pressure, which facilitate this process. A failure to load this system will mean the lymphatic system will not have a chance to perform its major task. (9)

2.13.2. Kinesio taping

Kinesio tex tape is made of 100% cotton and has elastic properties. It is this property that allows kinesio tex tape to work with the soft tissue of the body versus restricting it. It is the elasticity that makes kinesio tex tape a good modality for the treatment of lymphoedema and chronic swelling. (9)

Kinesio strip can be applied in the shape of a “Y”, “I”, “X”, “Fan”, “Web”, and “Donut”. The shape selected depends upon the size of the affected muscle and desired treatment effect. The “Y” technique is the most common method of application. It is used for surrounding a muscle to either facilitate or inhibit muscle stimuli. The basic principle of therapeutic taping for weakened muscles is to wrap the tape around the affected muscle. This is accomplished by using the “Y” strip. The “Y” strip should be approximately two inches longer than the muscle, measured from origin to insertion. The “I” strip can be used in place of the “Y” strip for an acutely injured muscle. The primary purpose of tape application following acute injury is to limit edema and pain. The “X” strip is used when a muscle’s origin and insertion may change depending upon the movement pattern of the joint (e.g.: Rhomboid). The “Fan” strip is used for lymphatic drainage which is an advanced concept. The “Web” is a modified fan cut. Both base ends are left intact, with the strips being cut in the mid section of the Kinesio strip. The "Donut" cut is primarily used for edema in a focal or sport-specific area. A series of two or three overlapping strips are applied with the center removed from the Kinesio Tex Tape, The center cut out, or "donut hole" is placed directly over the area to be treated. With any of the five strip types, it is helpful to round the ends of the tape prior to application. The rounding helps prevent the square edges from catching and may increase the length of tape application. (9)

There are two basic application directions for treatment of muscles. For acutely over-used or stretched muscles, the tape is applied from insertion to origin to inhibit muscle function. For chronically weak muscles or where increased contraction is desired, the tape is applied from origin to insertion to facilitate function. Insertion to origin application tape stretch/tension is very light or light, 15-25% of available tension. Origin to insertion application tension is light to moderate, 25-50% of available tension. (9)

Patella tendonitis – I strip

This technique for treating patella tendonitis uses an I strip placed from the tibial tuberosity over the patella. It is important during application that little or no tension is applied to the patella in an inward pressure to create increased articulation of the patella with the femur. (9)

Begin by placing the base of the Kinesio I strip inferior to the tibial tuberosity with no tension on the tape. With one hand, hold the base of the tape to ensure no tension will be created. (9)

- **Option 1 - ligament/tendon correction**

Apply moderate to severe tension (50-75% of available) from the tibial tuberosity to the inferior pole of the patella while the knee is in approximately 30 degrees of flexion. Slide the hand which was holding the base at the tibial tuberosity to the inferior pole of the patella. Instruct the patient to flex their knee. Apply very light tension (10-15% of available) to the Kinesio strip over the patella to within 2 inches of the end of the strip. Lay down the end of the Kinesio strip with no tension. Be sure to initiate adhesion prior to allowing the patient to extend the knee. (9)

- **Option 2 - space correction**

Have the patient place their knee in maximum flexion. Apply light tension (25% of available) to the Kinesio I strip over the patella. Lay down the last two inches with no tension. Be sure to initiate glue prior to any patient movement. (9)

When the patient extends the knee, the tape should create visible skin convolutions. If there are limited number of convolutions, too much tension has been applied to the tape. (9)

Patella tendonitis – U strip

This technique for treating patella tendonitis uses a U shaped application of the Kinesio strip under and around the patella. The function of the U strip is to apply an inward pressure on the inferior pole of the patella to create a “tilting” effect. This “tilting” effect is thought to decrease pressure on the inferior pole of the patella and reduce inflammation and pain. (9)

Begin by tearing the middle of the paper backing on a Kinesio strip approximately 6-8 inches in length. Place the middle of the tape strip with 1/3 to ½ width of the Kinesio strip over the inferior pole of the patella. A mechanical correction technique (tension and inward pressure) is applied using moderate tension (50% of available). Push the patella in an inward and inferior motion, in an attempt to “tilt” the patella. Instruct the patient to move the knee into flexion. As the patient moves the knee into flexion, apply the Kinesio strip around the patella with light tension (25% of available). The medial strip should be placed in the direction of the vastus medialis. The lateral strip should be placed in the direction of the vastus lateralis. (9)

No tension should be placed on either end. While the knee is in the flexed position, be sure to initiate glue adhesion prior to allowing the patient to extend their knee. (9)

Patella tendonitis – superior and inferior pole

Patella tendonitis at either the superior pole or inferior pole (jumper’s knee) develops from an overuse of the quadriceps muscle group. The patella acts like a mechanical lever to magnify the forces created by the quadriceps muscle. From repetitive activity, an inflammation may develop. (9)

- **Patella tendonitis – superior Y technique**

This is a modification of the quadriceps muscle taping. The tape is applied from the origin to the insertion. The split of the Y application begins at the superior pole of the patella instead of the junction of the vastus lateralis and medialis. Begin the kinesio Y strip approximately mid-thigh over the vastus medialis muscle. The thigh is placed in a flexed position. Apply light (25% of available) or paper-off tension until the Y in the Kinesio strip reaches the superior pole of the patella. Initiate glue activation prior to any further patient movement. (9)

Have the patient flex the knee to maximum flexion. Apply the tails of the Kinesio Y strip around the medial and lateral borders of the patella. The tails should be applied with light (25% of available) or paper-off tension. The tip of the tail should end with no tension on the tibial tuberosity. Initiate glue activation prior to any further patient movement. (9)

- **Patella tendonitis – inferior Y technique**

This technique is applied starting from just below the tibial tuberosity with no tension at the beginning. Light tension (25 % of available) is applied on the tape to the inferior pole of the patella. Have the patient place the knee into maximum flexion. Apply the tails of the Kinesio Y strip around the medial and lateral borders of the patella. The medial tail should end near or on the vastus medialis muscle, while the lateral tail should end on or near the vastus lateralis muscle. The tails should be applied with light tension (15-25% of available). A modification can be used to again split the tail (same tape) and apply a muscle application to either the vastus medialis or lateralis muscle thus creating further support. (9)

- **Combination of patella tendonitis superior and inferior Y techniques**

For acute or inflamed patella tendonitis, the practitioner may find better results from combining the two techniques described. Possibly for the first few days or week, a combination may be appropriate. As pain diminishes, the superior and inferior application alone may be sufficient for pain relief. (9)

Patella tracking syndrome

Patella tracking syndrome is one of the most common conditions of the knee. It may be caused by many factors: patella malalignment, genu varum, genu valgum, genu recurvatum, patella alta, patella balta, or a weak vastus medialis, to name a few. It is a chronic or degenerative condition in which the symptoms of pain and inflammation become more pronounced with increased activity. (9)

- **Option 1 – patella tracking laterally: I strip**

Application of a mechanical correction I strip. Begin by placing the patient's knee in 20-30 degrees of extension. Tear the paper backing of a 6-8 inch long Kinesio I strip in the middle. Holding both ends, apply a mechanical correction, using moderate to severe tension (50-70% of available) with inward pressure on the center of the Kinesio strip over the lateral border of the patella. (9)

The practitioner may either apply the mechanical correction tension while the knee is in extension, or have the patient move into flexion while the Kinesio strip is being applied. By applying the correction while the knee is actively moved into flexion it becomes more functional. Apply the mechanical correction tension around the lateral border of the patella. Tension ends as the Kinesio Tex Tape passes the superior and inferior poles of the patella. Lay down the ends of the Kinesio strip with no tension. If the corrective strip was applied with the knee in an extended position, have the patient move into flexion prior to tape ends application. (9)

- **Option 2 – patella tracking laterally: tension on tails**

With this technique, the tension is placed on the tails to use the "recoil effect" of the elastic qualities of the Kinesio Tex to create proprioceptive tension. Begin by applying the base of the Kinesio strip Y cut on the medial aspect of the patella with no tension. With one hand, hold the base to ensure no tension is added during application. One tail is applied with moderate tension (50% of available) and inward pressure along the inferior pole of the patella. The second tail is applied with similar tension and inward pressure along the superior of the patella. Before the patient moves the knee, make sure to activate the glue. The last approximately one inch of the tails of the mechanical correction tension on tails technique is applied with no tension. This is believed to pull the skin from the lateral to medial side of the knee. (9)

- **Option 3 – patella tracking laterally: tension on base**

For this technique, the practitioner mat either use the tension in the base of the Kinesio strip or use a manual correction to position the patella in the desired position. Begin with the first approximately two inches of the base of the Kinesio Y cut strip with no tension. With one hand, hold the initial application base to ensure no tension will be added. Apply appropriate tension to create desired proprioceptive stimulation. Moderate tension (50% of available) with inward pressure on the lateral border of the patella would be appropriate. As the tension is applied to the Kinesio strip, move the hand which has been holding the initial base tension up the Kinesio strip. (9)

It is felt that if the entire length of tape is applied to the skin as the tension is applied, it will reduce or minimize the recoil effect of the tape. By laying it down segmentally, it keeps the tension on the skin in each segment. Tension is applied over the crest of the lateral border of the patella. While holding the tension on the lateral border of the patella, have the patient move the knee into flexion. Lay down the superior tail along the superior border of the patella with no tension. Lay down the inferior tail along the inferior border of the patella with no tension. Prior to any further patient movement, activate the Kinesio strip glue by rubbing the tape application. This is believed to block lateral movement of the patella. (9)

2.13.3. Biolamp (bioptrone lamp)

The effect (biostimulation) is based on the use of polarized light, but unlike a laser it is not monochromatic, nor coherent. It is used to treat painful conditions of soft tissue structures (tendonitis, epicondylitis, bursitis etc.). It has practically no contraindications, but care must be taken not to expose to the eyes. (3)

In discharge lamps, the radiation is generated when current flows through gases or metal vapors. To convert the initially non-conductive gas to a conductive state, every discharge lamp needs to be ignited. This takes place by means of high voltages, which are briefly applied and which are generated by specially designed starters or ignition systems. (12)

The higher the vapor pressure in an arc tube, the longer is the warm-up time. This warm-up time can take up to 15 min. (12)

In contrast to incandescent lamps, in which the tungsten resistance increases as the current increases and which accordingly become self-stabilized at any lamp voltage, discharge lamps have a so-called negative current-resistance characteristic, that is to say, the greater the lamp current the smaller becomes the resistance of the discharge path; this, in turn, results in a further increase in current. Accordingly, without external current limitation, discharge lamps are destroyed through overheating, even after the briefest period of operation. To limit the current, all discharge lamps must additionally be operated with a control gear. (12)

For a few years, electronic adapter systems have also been commercially available, by which the losses can be reduced to 3%-10%. In addition, these systems are substantially lighter than heavy, iron-jacketed chokes, they ignite more rapidly, and since they are operated not with line frequency but at frequencies of a few thousand Hertz, the lamps give a steady light without flickering. (12)

Discharge lamps are supplied in many sizes and designs. The principle classification criterion is, however, the nature of the generation of the radiation and thus the primary spectrum of lamps. The following types are commercially available: (12)

- Low-pressure mercury lamps(12)
- High-pressure mercury lamps(12)
- Low-pressure sodium lamps(12)
- High-pressure sodium lamps(12)
- Metal-vapor lamps(12)
- High-pressure xenon lamps(12)
- High-pressure krypton lamps(12)

2.13.4. Magnetothrapy

When a muscle get's sprained or ligaments stretched, movement of the joint becomes very painful if not impossible. The magnetotherapy treatment is given by increasing the blood supply to the locally injured area, whether it is done by giving hot fomentation or by applying magnets to the area. (13)

The magnets here help in two ways, firstly, they increase the local blood circulation by attracting the Iron II of the blood, and secondly, they create a local magnetic field around that joint and thus help in relieving the pain as well as the stiffness. (13)

Pulsed magnetic field therapy devices produce pulses of alternating magnetic fields. The biologically compatible, magnetic energy subjects nerve and cell tissue to changing electrical potentials, which may induce a temporary analgesic effect and promote healing of damaged tissue. PMF devices utilize 120 volts of electricity (240 volt in some countries). This power is transformed to produce and alternating pulse at various frequencies. Portable models are powered with either 3 or 9-volt batteries. Many professional sports teams utilize electromagnetic therapy equipment. It is claimed that human athletes return to active status in half the normal time when using PMF therapy. Miniature battery powered PMF therapy units are produced in Austria, Canada and Australia. These devices produce a low energy magnetic field in a frequency range of .07 Hz (one pulse every 2 seconds) to 50 Hz (50 pulses per second). (15)

The biological effects of pulsed magnetic fields are proven and have been illustrated using infrared thermography. The thermographic pictures show a temperature increase due to an increase in blood circulation caused by the application of pulsed magnetic fields. The basic cell of an organism can be influenced by a pulsing magnetic field of certain frequency and intensity. It is recognized that in certain diseases, the resting and threshold potential of cells within the organism differ from the norm, thus impairing the function of the cell. Pulsed magnetic fields completely penetrate through every cell. The improvement of oxygen transport and oxygen saturation is due to the magnetic influences on hemoglobin at extremely low frequencies. At the cellular level the effects are increased oxygen diffusion in the cells, increased cell metabolism and mineral exchange. A pulsed magnetic field is clinically established to have analgesic, anti-inflammatory, and antiodemic effects. It improves circulation, accelerates tissue regeneration and provides a regulatory effect on the nervous system. (15)

Pulsating magnetic fields are known to produce the following effects among others: relief of pain and inflammation, stimulation of tissue, increased circulation, rehabilitation of tissue, increased relaxation (low frequencies), increased bowel movements (high frequencies). (15)

These effects have helped in treating the following ailments: diseases of the support and locomotory system (in particular rheumatic and arthritis disorders), sports injuries such as: bruises, pulled or torn ligaments and muscles, tennis elbow, delayed wound healing, headache and migraine, heart and circulatory diseases, circulatory disturbances, metabolic disorders, neuralgia, bronchitis and sinusitis - acute and chronic, skin ulcers. (15)

3.Special part

3.1. Methodology

The case study took place at Centrum Léčby Pohybového Aparátu Vysočany, Prague, from 11.01.10 until 29.01.10. This is a rehabilitation center specialized in adult orthopedic injuries and sports traumatology. The center provides a wide range of physiotherapeutic care for musculoskeletal injuries for both inpatients and outpatients. They offer individual treatments, electrotherapy, hydrotherapy and group exercises.

My work was supervised by Mgr. Zaher El Ali and all examinations and therapeutical procedures were done in cooperation and agreement with him.

The therapeutical methods undertaken at my workplace has been approved by the Ethics Committee of the Faculty of Physical Education and Sport at Charles University, Prague. The patient was informed of his inclusion in my bachelor work in the first, of my seven sessions with him in total.

3.2. Anamnesis

Examined person: J.K. – male.

Date of birth: 1972.

Diagnosis: The patient has a distended anterior cruciate- and medial collateral ligament of the left knee.

History: The pain occurred when he was playing football the 15th of December last year. He was tackled and sustained an impact to the lateral aspect of the left knee joint. The following twisting of the knee stretched the anterior cruciate- and the medial collateral ligament. Pain is constant and is located on the medial side of the knee. The patient has been wearing crutches since the accident occurred. His left knee is swollen. On a pain scale from 1-10 the patient describes the feeling of pain as 8. There is a limited range of motion and flexibility in the knee. Flexion of the knee makes it worse, while extending the knee relieves some of the pain.

Operations: none.

Diseases: none.

Allergies: none.

Abuses: alcohol occasionally, smoking 10 cigarettes per day.

Family anamnesis: Married, with no children.

Social anamnesis: He works as a fitter, but since injuring the knee in December he has been on a sick leave for 1 month. Hobbies: he is playing actively amateur football a couple of times a week for his local team in Prague.

Previous injuries: subluxation of right ankle.

Previous rehabilitation: Subluxation of right ankle 4 years ago.

Statement from the patient's medical documentation:

X-ray undertaken 15.12.2009 on the day of the injury, with no trauma causing changes to the skeleton.

Orthopaedic examination was undertaken the 21st of January. The findings were that there was hematoma by inner aperture surrounding the knee. The medial collateral ligament does not give sufficient stabilization to the knee joint.

Indication of rehabilitation:

None available.

Present state (Status presens): height: 178 cm, weight: 85 kg, BMI: 26.8 (overweight)

The doctor has ordered the patient to use the crutches for 1 month. The patient has been using a full extension orthesis around the knee ever since the accident, but is not using it when he comes to the clinic.

3.3. Initial kinesiologic examination

(The highlighted options in the table are indicated for the patient)

Table Nr. 5: Aspection

Aids	
Crutches	**Orthesis**
Scars	

Yes	**No**	
Skin colour		
Lighter	**Normal**	Darker
Swelling	Left knee	Right knee
	Yes	No

Table Nr. 6: Postural examination

Posterior view	Anterior view	Side view
Left achilles tendon is slightly deviated medially	Wide base of standing	Hyperlordosis in lumbar spine
Left scapula is higher	External rotation of left lower extremity	Flat thoracic spine
Prominence of spinal segment C7	Semiflexion of left knee	Slightly protracted shoulders
Rotation of the head to the left side	Left interaxillary space is larger	Standing more on the front part of foot
	Prominence of left pectoral muscles.	Plantar flexion of ankles

Table Nr. 7: Palpation

Temperature			
Low	**Normal**	High	
Palpation of cutis and subcutis around the affected knee			
No pain	Slight/moderate pain	Severe pain	
Muscle tone	**Hypotone**	**Normotone**	**Hypertone**
Vastus medialis	**Yes**	-	-

Vastus lateralis	-	**Yes**	-
Rectus femoris	-	**Yes**	-
Illiopsoas	-	**Yes**	-
Hamstrings	-	-	**Yes**
Hip adductors	-	**Yes**	-
Gluteus medius	-	**Yes**	-
Skin composition			
Dry	**Normal**	Moist	

Table Nr. 8: Scale weight

Right foot	**Left foot**
60 kg	48 kg

Table Nr. 9: Pelvic assesment

Area	**Comparison**
Illiac crest	Same height on both sides
Anterior spine	Same height on both sides
Posterior spine	Same height on both sides

Table Nr. 10: Anthropometric measurement

Circumference	**Right**	**Left**
Thigh	58 cm	57 cm
Above knee	47 cm	48 cm
Around patella	43 cm	46 cm

Tibial tuberosity	38 cm	42 cm

Table Nr. 11: Range of motion - active

Joint	Movement	Right	Left
Hip	Flexion	90 degrees	75 degrees
	Extension	15 degrees	15 degrees
	Abduction	35 degrees	35 degrees
	Adduction	20 degrees	20 degrees
	External rotation	25 degrees	15 degrees
	Internal rotation	20 degrees	30 degrees
Knee	Flexion	120 degrees	45 degrees
	Extension	0 degrees	-5 degrees (**?**)
Ankle	Dorsal flexion	30 degrees	25 degrees
	Plantar flexion	10 degrees	15 degrees
	Eversion	15 degrees	15 degrees
	Inversion	20 degrees	10 degrees

Table Nr. 12: Range of motion - passive

Joint	Movement	Right	Left
Hip	Flexion	90 degrees	80 degrees
	Extension	20 degrees	20 degrees
	Abduction	40 degrees	35 degrees
	Adduction	20 degrees	20 degrees
	External rotation	30 degrees	20 degrees

	Internal rotation	25 degrees	30 degrees
Knee	Flexion	125 degrees	45 degrees
	Extension	0 degrees	-5 degrees
Ankle	Dorsal flexion	30 degrees	25 degrees
	Plantar flexion	10 degrees	15 degrees
	Eversion	15 degrees	15 degrees
	Inversion	20 degrees	10 degrees

Table Nr. 13: Muscle strength examination

Muscle (group)	Right lower extremity	Left lower extremity
Hip flexors	Grade 5	Grade 5
Hip adductors	Grade 5	Grade 4
Gluteus medius	Grade 5	Grade 5
Quadriceps femoris	Grade 5	Grade 4
Hamstrings	Grade 5	*
Soleus	Grade 5	Grade 5
Gastrocnemius	Grade 5	Grade 5
Ankle dorsal flexors	Grade 5	Grade 5

***** The patient was unable to reach starting position for the test because of limited ROM in knee flexion.

Table Nr. 14: Soft tissue examination

Assesment of	Tissue	Right	Left
Knee	Cutis	No restriction	No restriction

	Subcutis	No restriction	No restriction
	Crural fascia	No restriction	Slight restriction
	Popliteal fascia	No restriction	No restriction
	Fascia Lata	No restriction	No restriction

Table Nr. 15: Knee ligament stability test – abduction/adduction test (valgus and varus stress test)

Test of the left knee joint	**Quality of end point**
Valgus stress test in 20 degrees knee flexion	firm
Valgus stress test in full knee extension	firm
Varus stress test in 20 degrees knee flexion	firm
Varus stress test in full knee extension	firm
Test of the right knee joint	**Quality of end point**
Valgus stress test in 20 degrees knee flexion	firm
Valgus stress test in full knee extension	firm
Varus stress test in 20 degrees knee flexion	firm
Varus stress test in full knee extension	firm

Table Nr. 16: Joint play examination

Examination of	**Direction**	**Right side**	**Left side**
Patella	Laterolaterally	No restriction	No restriction
	Cranially	No restriction	No restriction
	Caudally	No restriction	Slight restriction
Tibiofemoral joint	Laterolaterally	No restriction	No restriction

Fibular head	Ventrally	Slight restriction	**Restriction**
	Dorsally	Slight restriction	**Restriction**
Talocrural joint	Dorsally	No restriction	No restriction
Lisfranck joint	Ventrally	No restriction	No restriction
	Dorsally	No restriction	No restriction
Choppard joint	Ventrally	No restriction	No restriction
	Dorsally	No restriction	No restriction
Metatarsals	Ventrally	No restriction	No restriction
	Dorsally	No restriction	No restriction
	Laterolaterally	No restriction	No restriction

Table Nr. 17: Gait

Action	**Characteristics**
Trying to walk normally	Semiflexion of left knee
	Antalgic walk with a very short stance phase on the left lower limb.
	Short shuffling steps
	Wide gait
	Uncomfortable for patient
	Puts his heels in the ground first
	There is not complete rolling of foot
	No synkinesis of armswing
Walking on heels	Patient cannot walk more than one step
	Patient feels pain around tibial tuberosity

Walking on toes	Patient can do it as easy as normal walking
Standing on one foot	Slightly uncomfortable when standing on left foot
Squats	The patient is unable to do it due to pain.

Conclusion of examination

Physiological gait and locomotion is not present for this patient due to a dynamical defect. The patient is able to stand on his left lower extremity, but is finding it hard to move his feet one at a time. His hamstring muscles and quadriceps femoris muscle group of the left lower limb has reduced strength and the patient demonstrates problems when trying to bend his knee because of pain preventing him from completing the full range of motion in knee flexion. The most highlighted factor, however, is that the quadriceps femoris muscle group is compressed against the underlying bone on the left lower limb causing rupture of the muscle which leads to hematoma, resulting in the swelling that has occurred on the medial side of the knee. This is a structural defect and is compensated by incomplete rolling of his foot, 'stomping' it to the ground and he keeps a slight semi flexion at all times in his left knee joint, along with a wide base and short steps to retain balance.

3.4. Short-term and long-term rehabilitation plan

Table Nr. 18: Short-term and long-term rehabilitation plan

Short term	**Long term**
Instruction and reeduction on walking pattern, standing and foot position.	Enhance balance in standing and stability when walking with training on balance beams and stability boards.
Relieve pain on the medial side of the knee by means of soft tissue techniques around patella and area of knee.	Strenghten muscles around the knee and hip of the left lower extremity.
Increase joint play of patella and fibular head	Reach full range of motion in knee joint

of left lower extremity in all directions	(flexion and extension)
Decrease swelling around knee.	
Relieve tension in hypertoned muscle by means of PIR (quadriceps femoris)	

3.5. Therapy progress

Date: 11.01.2010

The patient is coming to see me for the first time.

Height: 178 cm, weight: 85 kg, BMI: 26.8 (overweight)

He is using crutches. The doctor has ordered the patient to use crutches for 1 month. The patient has been using a full extension orthesis around the knee ever since the accident, but is not using it when he comes to the clinic.

Goal of today's therapy unit (limited time for therapy because of anamnesis being time consuming)**:**

- Relieve pain in tissues around the knee by means of soft tissue technique.
- Relax knee extensor muscles by means of PIR.
- Strengthen hip adductors and knee extensors.

Procedure:

- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris and craniocaudal direction longitudinally to the quadriceps femoris by Lewit.
- Relaxation of m. quadriceps femoris with the patient lying in prone position on the table with the left knee flexed as much as he is able to without pain (about 45 degrees), by means of post isometric relaxation (PIR) by Lewit.
- Strengthening of m.quadriceps femoris with patient in supine position on the table pressing down on therapy ball which is placed under his left knee. He repeats this 10 reps. x 3 series.
- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain

barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this 10 reps. x 3 series.

Results:

Table Nr. 19: Results from 11.1. 2010

Objective results	Subjective results
Range of motion in knee flexion reached 50 degrees on the left leg, after PIR.	The patient executes the strengthening exercises using the therapy ball, according to plan and with ease.

Self-therapy:

- PIR autotherapy with max. 5 repetitions for m.quadriceps femoris of the left lower extremity according to Lewit.
- PIR autotherapy with max. 5 repetitions for hip adductors of left lower extremity according to Lewit.
- Put ice packs around the knee to reduce the swelling, and put the leg in an elevated position for 1 hour.

Date: 12.01.2010

The patient feels good from last session, and is eager to continue therapy.

Goal of today's therapy unit:

- Improve joint play of patella and fibular head.
- Relieve pain in tissues around the knee by means of soft tissue technique.
- Strengthen hip abductors, hip adductors, knee extensors and knee flexors.
- Improve stability in standing and assess how the left lower extremity as a whole handles load on the foot.

Procedure:

- Mobilization of the patella in a laterolateral direction and craniocaudal direction according to Manual Methods by Lewit.

- Mobilization of the head of fibula in dorsal and ventral direction according to Manual Methods by Lewit.
- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris and craniocaudal direction longitudinally to the quadriceps femoris according to Lewit.
- Strengthening of knee extensors (primarily m.quadriceps femoris) with patient in supine position pressing down on therapy ball which is placed under his left knee. He repeats this 10 reps. x 3 series.
- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this 10 reps. x 3 series.
- Strengthening of hip abductors (primarily m. glutes medius and m.gluteus minimus) against gravity with extended knee where patient is lying on his right side going into abduction by lifting his left lower extremity. He repeats this 10 reps. X 3 series.
- Strengthening of knee flexors (primarily hamstrings) against gravity with patient lying in prone position. He repeats this 10 reps. X 3 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with right foot firmly on the ground outside the apparatus, the **left foot on the posturomed** going from side to side and from front to back intermittently putting light load on the foot according to patients own feeling. He does this for 1 minute x 3-5 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with **both feet on the posturomed** going from side to side and from front to back intermittently putting light load on the left lower extremity according to patients own feeling. He does this for 1 minute x 3-5 series.

Results:

Table Nr. 20: Results from 12.1.2010

Objective results	**Subjective results**
Improved joint play of fibular head in both	The patient executes the strengthening

directions, but especially in ventral direction.	exercises using gravity and the therapy ball, according to plan and with ease.

Self-therapy:

- PIR autotherapy with max. 5 repetitions for m.quadriceps femoris of the left lower extremity according to Lewit.
- PIR autotherapy with max. 5 repetitions for hip adductors of left lower extremity according to Lewit.
- Autotherapy by contraction of m. vastus medialis with 10 reps x 3 series according to Lewit.
- Put ice packs around the knee to reduce the swelling, and put the leg in an elevated position for 1 hour.

Date: 15.01.2010

The patient feels better in the knee since last time. He says that bending the knee is less painful today. Inside the clinic, he is walking without crutches for the first time, although he will need them when walking outside. He is not wearing orthesis, because the doctor told him not to wear it anymore, only outside!

Goal of today's therapy unit:

- Re-examination of joint play in left lower extremity
- Relieve pain in tissues around the knee by means of soft tissue technique.
- Strengthen hip abductors, hip adductors, knee extensors and knee flexors.
- Improve stability in standing and assess how the left lower extremity as a whole handles load on the foot.

Procedure:

- Re-examination of joint play

Table Nr. 21: Re-examination of joint play

Examination of	Direction	Right side	Left side

Patella	Laterolaterally	No restriction	No restriction
	Cranially	No restriction	No restriction
	Caudally	No restriction	Slight restriction
Tibiofemoral joint	Laterolaterally	No restriction	No restriction
Fibular head	Ventrally	Slight restriction	**Restriction**
	Dorsally	Slight restriction	**Restriction**
Talocrural joint	Dorsally	No restriction	No restriction
Lisfranck joint	Ventrally	No restriction	Stiff
	Dorsally	No restriction	Stiff
Choppard joint	Ventrally	No restriction	Stiff
	Dorsally	No restriction	Stiff
Metatarsals	Ventrally	No restriction	No restriction
	Dorsally	No restriction	No restriction
	Laterolaterally	No restriction	No restriction

- Mobilization of the patella in a laterolateral direction and craniocaudal direction according to Manual Methods by Lewit.
- Mobilization of the head of fibula in dorsal and ventral direction according to Manual Methods by Lewit.
- Mobilization of the Lisfranck joint in dorsal and ventral direction according to Manual Methods by Lewit.
- Mobilization of the Choppard joint in dorsal and ventral direction according to Manua Methods by Lewit.
- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris, and in craniocaudal direction longitudinally to the quadriceps femoris according to Lewit.

- Relaxation of m. quadriceps femoris with the patient lying in prone position on the table, with the left knee flexed as much as he is able to without pain, by means of post isometric relaxation (PIR) according to Lewit.

- Lymphatic massage of the tissues around the knee according to Foeldi.

- Strengthening of knee extensors (primarily m.quadriceps femoris) with patient in supine position pressing down on therapy ball which is placed under his left knee. He repeats this **15 reps**. x 3 series.

- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this **15 reps**. x 3 series.

- Strengthening of hip abductors (primarily m. glutes medius and m.gluteus minimus) against gravity with extended knee where patient is lying on his right side going into abduction by lifting his left lower extremity. He repeats this **15 reps**. X 3 series.

- Strengthening of knee flexors (primarily hamstrings) against gravity with patient lying in prone position. He repeats this **15 reps**. X 3 series.

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with right foot firmly on the ground outside the apparatus, the **left foot on the posturomed** going from side to side and from front to back intermittently putting light load on the foot according to patients own feeling. He does this for 1 minute x 3-5 series.

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with **both feet on the posturomed** going from side to side and from front to back intermittently putting light load on the left lower extremity according to patients own feeling. He does this for 1 minute x 3-5 series.

Results:

Table Nr. 22: Results from 15.1.2010

Objective results	**Subjective results**
Improved joint play of Lisfranck and Choppard joints in both directions.	The patient feels slight discomfort when doing the heaviest posturomed exercises.

	We finish after 1 series.
The patient is able to balance on the posturomed on his weaker left lower extremity without putting the right lower extremity to the ground.	The patient thought the massage of the deep layers was comfortable.
Improved ROM in knee flexion of left lower extremity = 60 degrees	Skinbarrier of the tissues around the knee feels softer
Improved joint play of fibular head in ventral direction	The patient has improved his strength in all the muscle groups he has exercises for on the left lower extremity. Next week we will progress the exercises.

Self-therapy:

- PIR autotherapy with max. 5 repetitions for m.quadriceps femoris of the left lower extremity according to Lewit.
- PIR autotherapy with max. 5 repetitions for hip adductors of left lower extremity according to Lewit.
- Autotherapy by contraction of m. vastus medialis with 10 reps x 3 series according to Lewit.
- Put ice packs around the knee to reduce the swelling, and put the leg in an elevated position for 1 hour.

Date: 18.01.2010.

The patient is light at heart and optimistic. He has been on the ergometer bicycle for 40 minutes with very light intensity before he came to see me. Today the patient feels he has better strength and control of the knee.

Goal of today's therapy unit:

- Improve joint play of patella
- Re-examine lower extremities for strength

- Relieve pain in tissues around the knee by means of soft tissue technique.
- Strengthen hip abductors, hip adductors, knee extensors and knee flexors.
- Improve stability in standing and assess how the left lower extremity as a whole handles load on the foot.

Procedure:

- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris and craniocaudal direction longitudinally to the quadriceps femoris according to Lewit.
- Relaxation of m. quadriceps femoris with the patient lying in prone position on the table, with the left knee flexed as much as he is able to without pain, by means of post isometric relaxation (PIR) according to Lewit.
- Mobilization of the patella in a laterolateral direction and craniocaudal direction according to Manual Methods by Lewit.
- Strengthening of knee extensors (primarily m.quadriceps femoris) with patient in supine position pressing down on therapy ball which is placed under his left knee. He repeats this 10 reps. x 3 series with a **2 kg weight** belt around his leg.
- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this 10 reps. x 3 series with a **2 kg weight** belt around his leg.
- Strengthening of hip abductors (primarily m. glutes medius and m.gluteus minimus) against gravity with extended knee where patient is lying on his right side going into abduction by lifting his left lower extremity. He repeats this 10 reps. X 3 series with a **2 kg weight** belt around his leg.
- Strengthening of knee flexors (primarily hamstrings) against gravity with patient lying in prone position. He repeats this 10 reps. X 3 series with a **2 kg weight** belt around his leg.
- **Re-examination of muscle strength**

Table Nr. 23: Re-examinaiton of mucle strength

Muscle (group)	Right lower extremity	Left lower extremity
Hip flexors	Grade 5	Grade 5
Hip adductors	Grade 5	Grade 5
Hip abductors	Grade 5	Grade 5
Knee extensors	Grade 5	Grade 4
Knee flexors	Grade 5	Grade 4
Ankle plantar flexors	Grade 5	Grade 5
Ankle dorsal flxors	Grade 5	Grade 5

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with right foot firmly on the ground outside the apparatus, the **left foot on the posturomed** going from side to side and from front to back intermittently putting light load on the foot according to patients own feeling. He does this for 1 minute x 3-5 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with **both feet on the posturomed** going from side to side and from front to back intermittently putting light load on the left lower extremity according to patients own feeling. He does this for 1 minute x 3-5 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus. **Walking onto it with his left foot**, putting his weight over it, then transferring force from the foot to the posturomed as he gradually dorsal flexes the ankle and puts the other foot in front of him on the other side of the posturomed, as in normal walking. He does this for 1 minute x 3-5 series.

Results:

Table Nr. 24: Results from 18.1.2010

Objective results	Subjective results
Improved ROM of knee flexors of left lower extremity = 70 degrees!	I noticed todat that the patient is more fluent and confident when walking without crutches.

Improved joint play of patella in craniocaudal direction.	The patient feels no pain whatsoever when I am pressing with my fingers on the deep tissues on the medial side of the knee (primarily m.vastus medialis).
Improved muscle strength of hip adductors from grade 4 to grade 5!	-
Improved muscle strength of knee flexors from grade 3 to grade 4!	-

Self-therapy:

- PIR autotherapy with max. 5 repetitions for m.quadriceps femoris of the left lower extremity according Lewit.
- PIR autotherapy with max. 5 repetitions for hip adductors of left lower extremity according to Lewit.
- Put ice packs around the knee to reduce the swelling, and put the leg in an elevated position for 1 hour.

Date: 20.01.2010.

The patient feels no pain in the knee, just some tenderness on the medial side of the knee. The swelling is starting to subside. Tomorrow the patient will go to the doctor for a check-up of the knee.

Goal of today's therapy unit:

- Re-examine lower extremities for ROM.
- Improve joint play of patella, talocrural joint, lisfranck joint and head of fibula.
- Relieve pain in tissues around the knee by means of soft tissue technique.
- Strengthen hip abductors, hip adductors, knee extensors and knee flexors.
- Improve stability in standing.

Procedure:

- **Re-examination of Range of motion in lower extremities:**

Table Nr. 25: Re-examination of ROM in lower extremities

Joint	Movement	Right	Left
Hip	Flexion	90 degrees	80 degrees
	Extension	20 degrees	20 degrees
	Abduction	35 degrees	35 degrees
	Adduction	20 degrees	20 degrees
	External rotation	25 degrees	15 degrees
	Internal rotation	20 degrees	30 degrees
Knee	Flexion	120 degrees	80 degrees
	Extension	0 degrees	0 degrees
Ankle	Dorsal flexion	30 degrees	30 degrees
	Plantar flexion	10 degrees	15 degrees
	Eversion	15 degrees	15 degrees
	Inversion	20 degrees	10 degrees

- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris and craniocaudal direction longitudinally to the quadriceps femoris according to Lewit.

- Relaxation of m. quadriceps femoris with the patient lying in prone position on the table, with the left knee flexed as much as he is able to without pain, by means of post isometric relaxation (PIR) according to Lewit.

- Mobilization of the patella in a laterolateral direction and craniocaudal direction according to Manual Methods by Lewit.

- Mobilization of fibular head in ventral and dorsal direction according to Manual Methods by Lewit.

- Mobilization of the talocrural joint in dorsal direction according to Manual Methods by Lewit.
- Mobilization of Lisfranck joint in ventral and dorsal direction according to Manual Methods by Lewit.
- Strengthening of knee extensors (primarily m.quadriceps femoris) with patient in supine position pressing down on therapy ball which is placed under his left knee. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.
- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.
- Strengthening of hip abductors (primarily m. glutes medius and m.gluteus minimus) against gravity with extended knee where patient is lying on his right side going into abduction by lifting his left lower extremity. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.
- Strengthening of knee flexors (primarily hamstrings) against gravity with patient lying in prone position. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with right foot firmly on the ground outside the apparatus, the **left foot on the posturomed** going from side to side and from front to back intermittently putting light load on the foot according to patients own feeling. He does this for 1 minute x 3-5 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with **both feet on the posturomed** going from side to side and from front to back intermittently putting light load on the left lower extremity according to patients own feeling. He does this for 1 minute x 3-5 series.
- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus. **Walking onto it with his left foot**, putting his weight over it, then transferring force from the foot to the posturomed as he gradually dorsal flexes the ankle and puts the other foot in front of him on the other side of the posturomed, as in normal walking. He does this for 1 minute x 3-5 series.

Results:

Table Nr. 26: Results from 20.1.2010

Objective results	**Subjective results**
Improved ROM of knee flexors of left lower extremity = 80 degrees!	The patient seems to exhibit more control and flexibility over his left lower extremity and this is evidence by his increased efforts in the fitness room.
Slight improvement in ROM of left lower extremity in hip abduction = 35 degrees, hip flexion = 80 degrees and knee extension = 0 degrees	-
Improved joint play of talocrural joint in dorsal direction.	-
Improved joint play of Lisfranck joint in both directions.	-

Self-therapy:

- PIR autotherapy with max. 5 repetitions for m.quadriceps femoris of the left lower extremity according to Lewit.
- PIR autotherapy with max. 5 repetitions for hip adductors of left lower extremity according to Lewit.

Date: 21.01.2010.

Patient felt pain during night from yesterdays training session.

Goal of today's therapy unit:

- Improve joint play of patella, talocrural joint, lisfranck joint and head of fibula.
- Relieve pain in tissues around the knee by means of soft tissue technique.
- Strengthen hip abductors, hip adductors, knee extensors and knee flexors.

- Improve stability in standing.

Procedure:

- Soft tissue technique of skin and fascia around the patella in a laterolateral direction perpendicular to the muscle fibers of the quadriceps femoris and craniocaudal direction longitudinally to the quadriceps femoris according to Lewit.

- Mobilization of the patella in a laterolateral direction and craniocaudal direction according to Manual Methods by Lewit.

- Mobilization of fibular head in ventral and dorsal direction according to Manual Methods by Lewit.

- Mobilization of the talocrural joint in dorsal direction according to Manual Methods by Lewit.

- Mobilization of Lisfranck joint in ventral and dorsal direction according to Manual Methods by Lewit.

- Strengthening of knee extensors (primarily m.quadriceps femoris) with patient in supine position pressing down on therapy ball which is placed under his left knee. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.

- Strengthening of hip adductors with patient in supine position with his hips flexed approx. 90 degrees and knees flexed as much as possible before reaching pain barrier (45 degrees). Therapy ball is placed between knees and the patient presses his knees towards each other before release. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.

- Strengthening of hip abductors (primarily m. glutes medius and m.gluteus minimus) against gravity with extended knee where patient is lying on his right side going into abduction by lifting his left lower extremity. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.

- Strengthening of knee flexors (primarily hamstrings) against gravity with patient lying in prone position. He repeats this 10 reps. x **4** series with a 2 kg weight belt around his leg.

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with right foot firmly on the ground outside the apparatus, the **left foot on the posturomed** going from side to side and from front to back intermittently putting light load on the foot according to patients own feeling. He does this for 1 minute x 3-5 series.

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus standing with **both feet on the posturomed** going from side to side and from front to back intermittently putting light load on the left lower extremity according to patients own feeling. He does this for 1 minute x 3-5 series.

- Loading lower extremities to assess standing and improve balance by using a posturomed apparatus. **Walking onto it with his left foot**, putting his weight over it, then transferring force from the foot to the posturomed as he gradually dorsal flexes the ankle and puts the other foot in front of him on the other side of the posturomed, as in normal walking. He does this for 1 minute x 3-5 series.

Results:

Table Nr. 27: Results from 21.1. 2010

Objective results	**Subjective results**
Improved joint play of Lisfranck joint in both directions.	The patient is feeling a little soar in the muscles of the hip, hamstrings and quadriceps femoris especially.
Improved joint play of head of fibula in ventral and dorsal direction.	-
Improved joint play of talocrural joint in dorsal direction.	-

3.6. Final kinesiologic examination

(The highlighted options in the table are indicated for the patient)

Table Nr. 28: Final Aspection

Aids	
Crutches (only when walking outside)	**Orthesis (only when walking outside)**
Skin colour	

Lighter	**Normal**	Darker
Swelling	Left knee	Right knee
	No	No

Table Nr. 29: Final Scale weight

Right foot	**Left foot**
Initial: 60 kg **Final: 58 kg**	Initial: 48 kg **Final: 50 kg**

Table Nr. 30: Final Palpation

Temperature			
Low	**Normal**	High	
Palpation of cutis and subcutis around the affected knee			
No pain	Slight/moderate pain	Severe pain	
Palpation of deeper tissue around the affected knee			
No pain	Slight/moderate pain	Severe pain	
Muscle tone	**Hypotone**	**Normotone**	**Hypertone**
Vastus medialis	-	**Yes**	-
Vastus lateralis	-	**Yes**	-
Rectus femoris	-	**Yes**	-
Illiopsoas	-	**Yes**	-
Hamstrings	-	**Yes**	-
Hip adductors	-	**Yes**	-
Gluteus medius	-	**Yes**	-
Skin composition			

Dry	**Normal**	Moist

Table Nr. 31: Final Pelvic assesment

Area	**Comparison**
Illiac crest	Same height on both sides
Anterior spine	Same height on both sides
Posterior spine	Same height on both sides

Table Nr. 32: Final Anthropometric measurement

Circumference	**Right**	**Left**
Thigh	Initial:58 cm **Final:57 cm**	Initial:57 cm **Final:55 cm**
Above knee	Initial:47 cm **Final:45 cm**	Initial:48 cm **Final:47 cm**
Around patella	Initial:43 cm **Final:40 cm**	Initial:46 cm **Final:43 cm**
Tibial tuberosity	Initial:38 cm **Final:38 cm**	Initial:39 cm **Final:39 cm**

Table Nr. 33: Final Range of motion - active

Joint	**Movement**	**Right**	**Left**
Hip	Flexion	Initial:90 degrees **Final: 90 degrees**	Initial:75 degrees **Final: 80 degrees**
	Extension	Initial:15 degrees **Final: 20 degrees**	Initial:15 degrees **Final: 20 degrees**
	Abduction	Initial:35 degrees **Final: 35 degrees**	Initial:35 degrees **Final: 40 degrees**
	Adduction	Initial:20 degrees	Initial:20 degrees

		Final: 25 degrees	**Final:20 degrees**
	External rotation	Initial:25 degrees **Final: 25 degrees**	Initial:15 degrees **Final: 15 degrees**
	Internal rotation	Initial:20 degrees **Final:20 degrees**	Initial:30 degrees **Final:30 degrees**
Knee	Flexion	Initial:120 degrees **Final:125 degrees**	Initial:45 degrees **Final:110 degrees**
	Extension	Initial:0 degrees **Final: 0 degrees**	Initial:-5 degrees (**?**) **Final: 0 degrees**
Ankle	Dorsal flexion	Initial:30 degrees **Final:30 degrees**	Initial:25 degrees **Final:30 degrees**
	Plantar flexion	Initial:10 degrees **Final:10 degrees**	Initial:15 degrees **Final: 20 degrees**
	Eversion	Initial:15 degrees **Final: 15 degrees**	Initial:15 degrees **Final: 20 degrees**
	Inversion	Initial:20 degrees **Final: 20 degrees**	Initial:10 degrees **Final: 10 degrees**

Table Nr. 34: Final Range of motion - passive

Joint	**Movement**	**Right**	**Left**
Hip	Flexion	Initial:90 degrees **Final: 90 degrees**	Initial:80 degrees **Final: 85 degrees**
	Extension	Initial:20 degrees **Final: 20 degrees**	Initial:20 degrees **Final: 20 degrees**

	Abduction	Initial:40 degrees **Final: 40 degrees**	Initial:35 degrees **Final: 40 degrees**
	Adduction	Initial:20 degrees **Final: 25 degrees**	Initial:20 degrees **Final:20 degrees**
	External rotation	Initial:30 degrees **Final: 30 degrees**	Initial:20 degrees **Final: 20 degrees**
	Internal rotation	Initial:25 degrees **Final:25 degrees**	Initial:30 degrees **Final:30 degrees**
Knee	Flexion	Initial:125 degrees **Final:125 degrees**	Initial:45 degrees **Final:110 degrees**
	Extension	Initial:0 degrees **Final: 0 degrees**	Initial:-5 degrees **Final: 0 degrees**
Ankle	Dorsal flexion	Initial:30 degrees **Final:30 degrees**	Initial:25 degrees **Final:30 degrees**
	Plantar flexion	Initial:10 degrees **Final:10 degrees**	Initial:15 degrees **Final: 20 degrees**
	Eversion	Initial:15 degrees **Final: 15 degrees**	Initial:15 degrees **Final: 20 degrees**
	Inversion	Initial:20 degrees **Final: 20 degrees**	Initial:10 degrees **Final: 10 degrees**

Table Nr. 35: Final Muscle strength examination

Muscle (group)	**Right lower extremity**	**Left lower extremity**
Hip flexors	Initial:Grade 5	Initial:Grade 5

	Final:Grade 5	**Final:Grade 5**
Hip adductors	Initial:Grade 5 **Final: Grade 5**	Initial:Grade 4 **Final:Grade 5**
Gluteus Medius	Initial:Grade 5 **Final: Grade 5**	Initial:Grade 5 **Final:Grade 5**
Quadriceps femoris	Initial:Grade 5 **Final: Grade 5**	Initial:Grade 4 **Final:Grade 5**
Hamstrings	Initial:Grade 5 **Final: Grade 5**	Initial: * **Final:Grade 4**
Soleus	Initial:Grade 5 **Final: Grade 5**	Initial:Grade 5 **Final:Grade 5**
Gastrocnemius	Initial:Grade 5 **Final: Grade 5**	Initial:Grade 5 **Final:Grade 5**
Ankle dorsal flexors	Initial:Grade 5 Final: Grade 5	Initial:Grade 5 Final:Grade 5

***** The patient was unable to reach starting position for the test because of limited ROM in knee flexion.

Table Nr. 36: Final Soft tissue examination

Assesment of	**Tissue**	**Right**	**Left**
Knee	Cutis	Initial:Unrestricted **Final: Unrestricted**	Initial:Unrestricted **Final: Unrestricted**
	Subcutis	Initial:Unrestricted **Final: Unrestricted**	Initial:Unrestricted **Final: Unrestricted**
	Crural fascia	Initial:Unrestricted **Final: Unrestricted**	Initial:Slight restriction **Final: Unrestricted**

	Popliteal fascia	Initial:Unrestricted **Final: Unrestricted**	Initial: Unrestricted **Final: Unrestricted**
	Fascia Late	Initial: Unrestricted **Final: Unrestricted**	Initial: Unrestricted **Final: Unrestricted**

Table Nr. 37: Final Knee ligament stability test – abduction/adduction test (valgus and varus stress test)

Test of the left knee joint	**Quality of end point**
Valgus stress test in 20 degrees knee flexion	Initial:firm **Final: firm**
Valgus stress test in full knee extension	Initial:firm **Final: firm**
Varus stress test in 20 degrees knee flexion	Initial:firm **Final: firm**
Varus stress test in full knee extension	Initial:firm **Final: firm**
Test of the right knee joint	**Quality of end point**
Valgus stress test in 20 degrees knee flexion	Initial:firm **Final: firm**
Valgus stress test in full knee extension	Initial:firm **Final: firm**
Varus stress test in 20 degrees knee flexion	Initial:firm **Final: firm**
Varus stress test in full knee extension	Initial:firm **Final: firm**

Table Nr. 38: Final Joint play examination

Examination of	**Direction**	**Right side**	**Left side**
Patella	Laterolaterally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
	Cranially	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No**

			restriction
	Caudally	Initial:No restriction **Final: No restriction**	Initial:Slight restriction **Final: No restriction**
Tibiofemoral joint	Laterolaterally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
Fibular head	Ventrally	Initial:Slight restriction **Final:slight restriction**	Initial:Restriction **Final:slight restriction**
	Dorsally	Initial:Slight restriction **Final:slight restriction**	Initial:Restriction **Final:slight restriction**
Talocrural joint	Dorsally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
Lisfranck joint	Ventrally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
	Dorsally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
Choppard joint	Ventrally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
	Dorsally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
Metatarsals	Ventrally	Initial:No restriction	Initial:No restriction

		Final: No restriction	**Final: No restriction**
	Dorsally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**
	Laterolaterally	Initial:No restriction **Final: No restriction**	Initial:No restriction **Final: No restriction**

Table Nr. 39: Final Gait

Action	**Characteristics**
Walking normally	Semiflexion of left knee
	The stance phase is still shorter on the left lower limb than on the right.
	Normal length of steps
	Wide gait
	No pain
	Puts his heels in the ground first
	There is not complete rolling of foot
	No synkinesis of armswing
Walking on heels	Patient can walk a few steps, but stops due to pain around area of tibial tuberosity
Walking on toes	Patient can do it as easy as normal walking
Standing on one foot	He is standing just as comfortable on the left foot as on the right
Squats	The patient can do squats, but is getting muscle shakings in his left lower extremity

3.7. Therapy effect evaluation, prognosis

The swelling of the affected lower extremity has subsided. The table below shows a difference 2 cm around the thigh, 1 cm above the knee, 3 cm around patella, and 3 cm around the tibial tuberosity. The patient has responded well to the strength exercises in the fitness room, as is evidence of his improvement in muscle strength of the hamstrings, quadriceps femoris and hip adductors of the affected lower extremity. The hamstrings were impossible to test for strength at the initial examination as the knee ROM did not allow for it, and pain was present. At the final examination, not only could the patient move through most of the ROM in knee flexion, but the result of grade 4 in muscle strength is quite satisfactory after 2 weeks of therapy. There has been an improvement in ROM of the affected lower extremity, particularly for knee flexion (from 45 – 110 degrees), but knee extension is also highlighted due to the fact that it is possible to put the knee in neutral position.

I would do more tests of the ligaments and meniscus. I simply did not do them in the initial examination, partly because of the fact the patient felt so akward in getting into the starting positions for the tests (e.g. anterior drawer test), I was only able to perform the varus and valgus stress test. This is not sufficient in determining the state of the ligaments and menisci of the knee, instead I should have combined the evaluation with more tests. The patient will need to go for an MRI verify any findings anyway.

The parameters listed in the tables below are the main changes from the kinesiologic examinations in my case study. Note, that the highlighted parameters have seen marked improvements.

Table Nr. 40: Circumference

Date of therapy / **Measured lower extremity**	**11.1 2010 Right**	**11.1 2010 Left**	**29.1 2010 Right**	**29.1 2010 Left**

Circumference of thigh	58 cm	57 cm	57 cm	55 cm
Circumference above knee	47 cm	48 cm	45 cm	47 cm
Circumference around patella	43 cm	46 cm	40 cm	43 cm
Circumference of tibial tuberosity	38 cm	42 cm	38 cm	39 cm

Table Nr. 41: Range of motion – active (comparison)

Date of therapy / **Measured lower extremity**	**11.1 2010 Right**	**11.1 2010 Left**	**20.1 2010 Right**	**20.1 2010 Left**	**29.1 2010 Right**	**29.1 2010 Left**
Hip flexion	90 degrees	75 degrees	90 degrees	80 degrees	90 degrees	80 degrees
Hip extension	15 degrees	15 degrees	20 degrees	20 degrees	20 degrees	20 degrees
Hip abduction	35 degrees	35 degrees	35 degrees	35 degrees	35 degrees	40 degrees
Knee flexion	120 degrees	45 degrees	120 degrees	80 degrees	125 degrees	110 degrees
Knee extension	0 degrees	-5 degrees	0 degrees	0 degrees	0 degrees	0 degrees

Table Nr. 42: Muscle strength examination (comparison)

Date of therapy	**11.1**	**11.1**	**18.1**	**18.1**	**29.1**	**29.1**

Measured lower extremity	2010 Right	2010 Left	2010 Right	2010 Left	2010 Right	2010 Left
Hip adductors	Grade 5	Grade 4	Grade 5	Grade 5	Grade 5	Grade 5
Hamstrings	Grade 5	*	Grade 5	Grade 4	Grade 5	Grade 4
Quadriceps femoris	Grade 5	Grade 4	Grade 5	Grade 4	Grade 5	Grade 5

***** The patient was unable to reach starting position for the test because of limited ROM in knee flexion.

The prognosis is uncertain. Since the patient has not been to an MRI scan, and there has not been established if there is a stetched anterocruciate- and mediocollateral ligament or a ligament tear, the prognosis will have to be divided into two possible outcomes.

For stretched ligaments the treatment time is usually 8 weeks. It is now 6 weeks since the injury occurred. In which case the patient should regain close to full muscle strength and mobility in the near future.

If there is a tear to the acl ligament, reconstruction of the anterocruciate ligament, taking tissue from i.e. the patellar tendon, is an option. The anterocruciate ligament has special properties that is not easily replaced by artificial interventions, in any case, there are many patients who have undergone such surgery in the knee and gone back to their previous life styles. However, rehabilitation will take many months in order to regain the strength and function necessary to return to playing football..Rehabilitation will initially be focused on regaining ROM, then strength and balance, after that more sport specific exercises, and finally inrestricted sports. The patient can choose to wear a sports brace after returning to physical activity

4. Conclusion

I feel proud and privileged to be associated with the workplace I had, CLPA, and the physiotherapists and staff at the clinic. It is a well run clinic, with good routines and work attitude, which makes this the best clinic I have undertaken physiotherapy practice in Prague.

My main expectation was to be able to work closer with sports injuries, and I am delighted with my patient and the diagnosis I got. I find it interesting, and it is an area of treatment in which I would like to specialize within. I felt all examinations were undertaken according to standard procedure when dealing with the knee, and that I had the patients trust even though he didn't speak English, and my Czech knowledge still leaves a lot to be desired for. Still, I feel I was able to explain to him clearly, by showing him positions and exercises etc. Besides, the patient was a motivated and sporty person, willing to push himself a little in the fitness room, and as we had more sessions he felt more comfortable with handling the pain.

The only area where I felt I wanted to do more examinations was with ligament tests. The first week or so, the patient wasn't able to reach the starting position for a lot of the ligament tests, so that limited my assessment of the knee somewhat. Also, it would have been a much more straightforward therapy evaluation and prognosis making if the patient had done a MRI scan to determine if the ligaments were ruptured or stretched before he came to the clinic for the initial examinations.

Looking back, it would have been thrilling to follow the patient further to see how he adjusts to football related exercises like dribbling with the ball, and running sideways, zigzag, and taking sidesteps, and last but not least how the patient would cope with unrestricted activity, as in playing football. After all, this is the goal I, my supervisor at CLPA, and the patient is working towards achieving.

5. Bibliografi

1.Buckup, Klaus. Clinical Tests for the Musculosceletal System . Thieme, 2004. 3-13-136791-1

2.Chaitov, Leon. Palpation and assessment skills – assessment and diagnosis through touch. Churchill Livingstone, an imprint of Elsevier Limited, 2003. 0-443-07218-3

3.Clague, Roy, Herold, Manfred, Bayer, Milan, Tauchmannova, Helena, Ferencik, Miroslav and Killinger, Zdenko. Dictionary of Rheumatic Disease. Springer-Verlag/Wien, 2009. 978-3-211-68584-6

4.Davies, Andrew, Blakeley, Asa and Kidd, Cecil. Human Physiology. Churchill Livingstone – An imprint of Harcourt Publishers Limited., 2001. 0443-045593

5.Drake, Richard, Vogl, Wayne and Mitchell, Adam. Gray's Anatomy for students. Churchill Livingstone - An imprint of Elsevier Inc., 2005. 0-8089-2306-4.

6.Ebnezar, John. Essentials of orthopaedics for physiotherapists. Jaypee Brothers Medical Publishers, 2003. 81-8061-114-0

7.Fitzgerald, Robert, Kaufer, Herbert and Malkani, Arthur. Orthopaedics. Mosby Inc., 2002. 0-323-01318-X

8.Hall, Susan J. Basic Biomechanics – second edition. Mosby – Year Book Inc., 1995. 0-8151-4077-0

9.Kase, Kenzo and Stockheimer, Kim. Kinesiotaping for lymphoedema and chronic swelling. Kinesi USA, LLC., 2006

10.Keir, Lucille, Wise, Barbara and Krebs, Connie. Medical assisting – administrative and clinical competencies, fourth edition. Thomson – Delmar Learning., 1998. 0-8273-7712-6

11.Kendall, Florence Peterson. Muscles - testing and function with posture and pain. Lippincott Williams and Wilkins., 2005. 0-7817-4780-5

12. Krutman, Jean, Honigsmann, Helmut, Elmets, Craig and Bergstresser, Paul. Dermatological phototherapy and photodiagnostic methods. Springer-verlag Berlin, 2001. 3-540-67789-5

13.New Dawn. Magnetotherapy. Sterling Publisher Private Limited., 2000. 81-207-2276-0

14.Peterson, Lars and Renstrom, Per. Sports injuries - their prevention and treatment 3rd edition. Martin Dunitz – an imprint of the Taylor and Francis Group, 2001. 1 85317 119 0

15.Rinker, Fred. The invisible force - traditional magnetic therapy. Mason service publishing, 1997. 0-9681900-0-6.

16.Schultz, Sandra, Houglum, Peggy and Perrin, David. Examination of musculoskeletal injuries – 2nd edition. Human Kinetics, 2005. 0-7360-5138-4

17.Smith, Laura K, Weiss, Elizabeth and Lehmkuhl, Don. Brunnstrom's Cilnical Kinesiology – fifth edition. F.A Davis Company., 1996. 0-8036-7916-5

6. Supplement

<u>Tables:</u>

Photos:

Picture 1: Knee anatomy retrieved from Gray's Anatomy for Students, 2005, Drake, Richard, Vogl, Wayne and Mitchell, Adam.

Picture 2: Menisci overview retrieved from Gray's Anatomy for Students, 2005, Drake, Richard, Vogl, Wayne and Mitchell, Adam.

Picture 3: Knee alignment retrieved from Gray's Anatomy for Students, 2005, Drake, Richard, Vogl, Wayne and Mitchell, Adam.

Picture 4: Ligaments retrieved from Gray's Anatomy for Students, 2005, Drake, Richard, Vogl, Wayne and Mitchell, Adam.

Picture 5: Muscles retrieved from Gray's Anatomy for Students, 2005, Drake, Richard, Vogl, Wayne and Mitchell, Adam.

Abbrevations:

ACL = Anterior cruciate ligament

CLPA = Centrum léčby pohybového aparátu Vysočany

EMG = Electromyography

LCL = Lateral collateral ligament

MCL = Medial collateral ligament

PCL = Posterior cruciate ligament

P.I.R = Post-isometric relaxation

ROM = Range of motion

VML = Vastus medialis longus

VMO = Vastus medialis oblique